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Compressed Air Motors for City Railways.

To run a horse car, or as they are sometimes called, a tramway car, by compressed air a distance of ten or twelve miles, and to do it with certainty, safety, and economy, is something that has been eagerly sought for within the last few years, and to do away with the necessity of using horses. Experiments made in France, Scotland, and in this country go to show, in spite of almost insuperable difficulties, that we are on the eve of solving this difficult mechanical problem; in fact, there is a company formed in the city of New York, which took hold of this matter some two years ago, and have succeeded in running a composite car—that is, one propelling itself, and at the same time carrying passengers, the above-mentioned distance, and had about 25 per cent. of the air that was charged at the end of the run.

In the construction of this car, a sufficient volume of air, compressed to a pressure of 350 pounds to the square inch, is stored in steel cylinders under the seats and platform of the car; this is used to give motion to a pair of engines, having a valve motion, so arranged as to expand the air from the above stated high initial pressure down to about atmospheric pressure; by this means they are able to run the car to a distance of over 12 miles at any speed desired, and with an entire absence of smoke, cinders, and noise. To realize fully the manner in which this motor acts upon the engines which drive the car, it is only necessary to consider that the air is a highly elastic medium, which, when compressed by engines specially designed for the purpose, is in about the same condition for transmitting power that a huge clock spring would be that had been wound up by a steam engine.

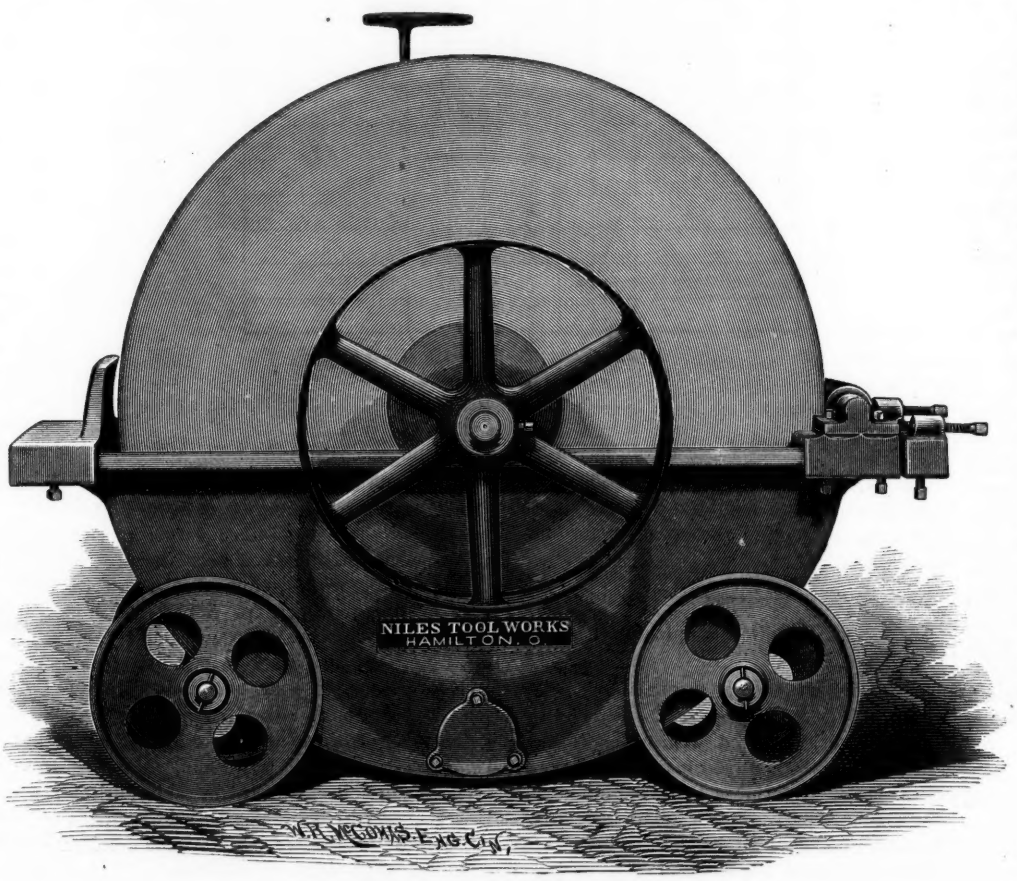
On the premises of the above-mentioned company there are a pair of high pressure engines having cylinders 12″ bore x 36″ stroke, working under a pressure of 80 lbs. of steam to the square inch. Both engines are coupled; the piston rod of each engine projects through the back cylinder heads, and are coupled direct to the piston rods of the air compressors; the diameter of one of the cylinders of the air compressors is 12″ by the same stroke as the engine, and compresses the air to a pressure of 80 lbs. to the square inch; this air is now passed to the other compressing cylinder, having a bore of 6 inches, where it is compressed to a pressure of 350 lbs. to the square inch; on leaving the cylinder it is passed through a cooling tank which reduces its temperature to about the same as the water by which it is cooled; in this condition as to temperature and pressure, it is allowed to flow into a tank, or receiver, from which the cars, as they come in from their trips are charged.

In the present case the time necessary to charge a car with air does not occupy over five minutes, but, by increasing the capacity of the compressors, cars can be charged in one minute.

In the matter of safety of life to passengers, this compressed air tramway car has important advantages over any steam motor. The car being coupled to the receiving tanks, or directly to the compressor, to receive its charge of compressed air, is necessarily stationary. The tanks on the car when fully charged are bearing the greatest strain, or liability to rupture that they are subjected to. From the time the car is moved until it returns to be charged again, the pressure is falling with every revolution the wheels make, consequently all danger from explosion from over pressure is avoided when the car leaves the charging tank, or compressor, and starts on its trip. The control of the car when under motion is so complete that the driver can bring it to a stop in half its length in descending grades, by simply reversing the valve motion. The engines become air-compressors driven by gravity, or the weight of the car falling the height of the incline, thus utilizing the power by returning air to the tanks, which power in the case of steam motors is dissipated in the brakes.

In some situations it may be more desirable to run independent dummies, not carrying passengers on the motor, but simply hauling one or more cars on the track, by this means a much lighter motor can be constructed, quite suitable where there are no heavy grades. We predict that the time is not far distant when this plan of motor will come into common use, doing away largely with the use of horses for this purpose, it having numerous and important advantages to recommend it over steam for surface tramways and city elevated roads.

On this page is represented a side elevation showing the arrangement of the engines, as they are applied to compressed air cars as they are now running in this city: *A, A*, represent air tanks; *B, B*, wheel axles, one of which is the crank axle. They are both coupled together by outside coupling rods; *C, C*, are yoke bars for eccentric straps. The eccentric rods are attached to the yoke bars, so that a uniform motion is transmitted from the eccentrics to the valve, irrespective of the vertical movement of the machine. *D* is the radius bar which gives motion to the cut-off valve, taking its motion from the inside slot of the suspended link, *K*; *E* is the radius bar which gives motion to the main slide valve, it receiving its motion from the outside of stationary link *K*; *F* is the air chest; *G*, air cylinder; *H*, an air supply-pipe; *I, I*, reversing levers; *M, M*, air pipes from tanks to air cylinders; *N*, stud for link; *O*, piston crosshead; *P, P*, eccentrics forged on shaft.

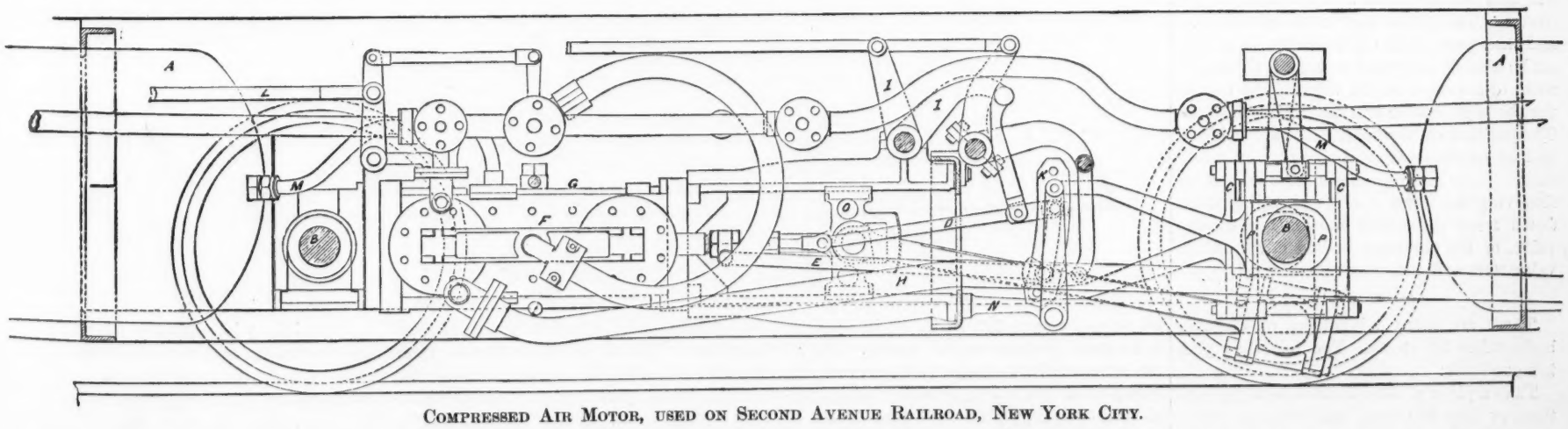


New Grindstone Mounting.

Mounted Grindstones.

A grindstone is hardly a machine tool, but without the grindstone there would be no machine tools. Good tools are essential to good and economical workmanship, and good grindstones are essential to good tool-grinding.

We illustrate on this page a grindstone box, which is an excellent example of "a thing well done." In the first place, the whole machine is good looking, and next, it is heavy and substantial enough to secure a perfect steadiness. The center mountings are excellent. A large square arbor provided with flanges and nuts secures the stone. The arbor runs in self-adjusting, and self-oiling boxes of great length. The rest is very solid, and is arranged to return to the trough all water which may pass over it. A rest for a water vessel is provided. The self-turning device is a treaded cylinder, revolving in contact with the stone. It cuts away the stone and keeps it always perfectly true. It



Compressed Air Motor, used on Second Avenue Railroad, New York City.

works while the stone is wet, and thus avoids the damage and nuisance of grit floating in the shop while the stone is being turned. The box is tight, and thus guards against slopping and trickling of water from floor to floor.

The whole machine is mounted on wheels, which allows the box to be wheeled under a crane when a new stone is mounted; it allows it to be wheeled to the door when sediment is to be cleaned from hand-holes; it allows the belt to be kept tight; and it allows a change to be made in the pulley as the stone gets smaller, without the necessity of cutting the belt. The box is a single handsome casting. It receives a stone four feet in diameter, and eight inches face. The complete weight is nine hundred pounds. It is one of the products of the Niles Tool Works, of Hamilton, Ohio.

Motion Curves.

BY V. HOOK.

The laying off of motion curves presents to the eye *all* of the movements of the valve at a glance. Fig. 1 shows the diagram after it is completed, ready to file away for future reference. Elevations of the ports are laid out to a scale and in length equal to the stroke of the piston, with the inches marked as shown. We start with the valve V, as shown at the commencement of the stroke, and, by means of the diagram described in a former article, or by other means, get the position of the valve for several positions of the piston, or for each inch, as shown at *a, b, c, d.* When all of the positions are obtained and jotted down on the port elevations, a curve that cuts them all is drawn, as are similar curves, for the other edges of the valve. The opposite curves can also be laid down, and the movements of the valve for the opposite stroke obtained. In the diagram shown, we see that the port S′ was wide open at *h*, or 4½ in. of piston travel, that steam was cut off at *c*, 18 in.; exhaust opened at *f* 19½ in., and compression commenced at *g* 19½ in. also, the valve being "line and line." Other points can be obtained by inspection, and the diagram forms valuable data for the builder and user. The plan shown in Fig. 2 I saw used in a western shop for obtaining the curves. A board, F, to which a piece of paper is fastened, is bolted to the cross-head, G, as shown. A temporary rocker shaft, H, is mounted, the two arms being at right angles to each other. The lower arm has a pencil, *a*, which just bears on the paper. The other arm, E, is connected by a rod, C, to valve stem, V, at D by a pin. The arm H is set square with the valve, or rocker shaft, I. A revolution of the engine is made by hand, and the curve *b, c,* traced. The lower arm is placed half way between its extreme points of travel, the upper arm disconnected and the line, A, B, drawn. The paper may now be removed and the ports laid off centrally from line A, B; that is, the curve represents the movement of the *center* of the valve. The curves for the edges can be laid down from this one. The position of the board, etc., are evident, and no explanation on these points is necessary. These curves can also be obtained by removing the chest cover, and laying them down from the actual movements of the valve, or the ports can be laid down on the valve stem and a stationary tram used.

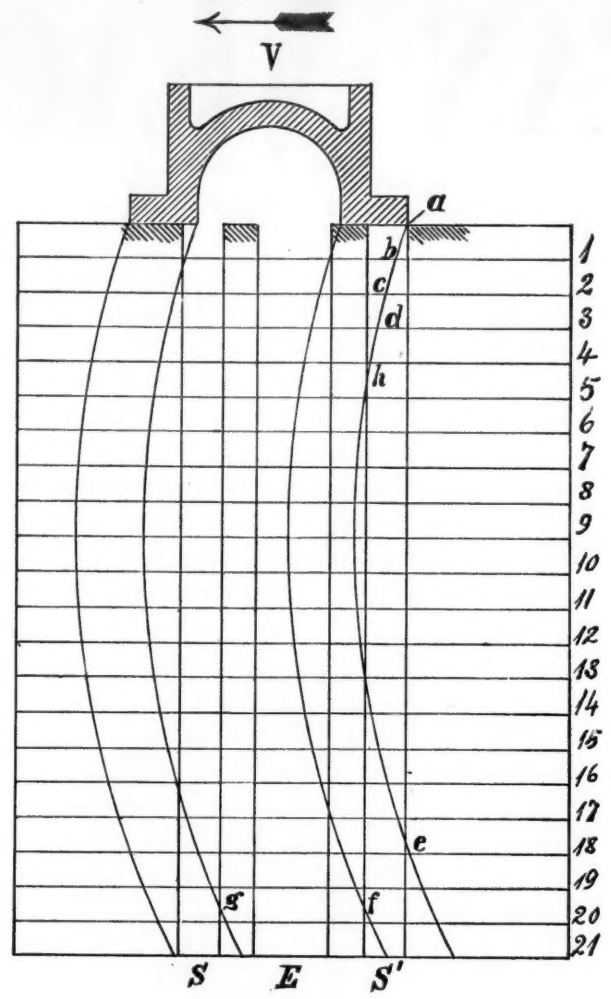


Fig 1.

There are many advantages of cleaning boiler-tubes by steam. The following plan is a good one:

Take a piece of three-fourths inch gas-pipe three or four feet long, and bend one end so that it will reach, say six inches, into the boiler tube. To the straight end attach a piece of rubber hose extending to a steam pipe leading from the boiler. For use in horizontal boilers, the gas-pipe need not, of course, be bent at one end. To enable the pipe to be handled it must necessarily be covered with a piece of felt, or other non-conducting material. The steam being turned on, the operator inserts the outer end of the pipe into the lower end of a tube, and the escaping steam soon cleanses the inside of the tube without disturbing the working of the boiler, or subjecting the operator to heat, smoke, or dirt.

Steam Boiler Explosions.

BY WILLIAM J. WILLIAMS.

No subject connected with the steam engine seems to be involved in such mystery as steam boiler explosions. If the engine breaks down in any part, or even if an almost total demolition occurs, it takes but little time to give the cause of the disaster and to place the fault where it belongs. We have mechanics who can and do build engines that use the steam furnished from the boiler to suit their different views on the subject; they are perfectly acquainted with all its qualities as an agent to create motive power. But let the boiler explode, except from unmistakable evidences of low water, or safety valves rusted fast, or equally plain facts that cannot be very well concealed from the practiced eye, and satisfactory conclusions are hardly ever arrived at. Many theories are advanced, some of them very probable, and many of them require a great deal of qualification, to say the least of them. It is not my purpose to recount over the various so-called causes of boiler explosions, but merely to call attention to some thoughts on the subject—thoughts that are ever recurring to my mind when about one First, that a boiler when set and ready to work, is a beam, supported, perhaps, at the two ends only; and that the *beam* is a *lever*—the first of mechanical powers, and that not only the weight of the water within, but that the total force or pressure, perhaps a 1,000 tons, is ever ready to act on that lever; it is ever seeking the weakest place, that it may break from its prison. Looking at it from the lever point of view, is it any wonder that strong boilers are sometimes torn into shreds, as it were.

The steam boiler, when at work, is subjected to two irresistible forces called expansion and contraction; if we could make a boiler of one piece of uniform thickness, with the edges welded together, the whole of uniform expansive qualities, and apply heat around its entire circumference, it would be a beam whose sides would be straight and parallel to each other, but it would be expanded or lengthened. But as we cannot procure tubes of sufficient magnitude, we have to make our boilers of many parts and rivet them together. Perhaps no two pieces being of exactly the same thickness, or having equal properties for expansion and contraction, and if we take into account that where each piece is joined to the other is double the thickness of other parts, many rivets having to sustain more than their share of the strain, from imperfections in making, it would be almost too much to expect the boiler to be a beam that is perfectly straight under any condition, although it might appear to be so, and perfectly cylindrical, even to a practiced eye. As in practice, heat is only applied to about two-thirds, or perhaps less in some instances, of the circumference, we cannot expect it to be a beam whose sides are straight and parallel. As the bottom is subjected to the greatest heat, this part will be expanded the most, and will cause the boiler to be a deflected beam, in the middle of its length on the top there would be a compression, because this part is not subjected to the same intensity of heat, therfore it has not lengthened as much; here are two forces opposing each other, nor, perhaps, would it matter a great deal, practically, if we could always keep the heat underneath of the same intensity, and the steam pressure within of a uniform tension, thereby maintaining a constant quantity of heat within and without. We know that under the most favorable circumstances, this cannot be attained; the fire will want replenishing with fuel, the steam will vary in pressure, and the boiler, under these variations, is continually expanding and contracting; the beam is deflected of different degrees, it being shortened and lengthened every few minutes; in fact, it is not constant at any time, ever changing in form and length. If we look around and see the manner in which steam boilers *have* to be fired, see the constant variations of steam pressure, and if we suppose such light fuel as shavings, for instance, causing flashes of heat for a few moments, and then for a space of time a rush of air through bare fire-bars, of whatever temperature it may happen to be without doors, how many times does it occur in a day, how long will the iron in the boiler stand it? It is admitted by all engineers of experience, that a few extra pounds of steam will not injure a boiler half as much as hard firing will. Hard firing is generally meant to be subjecting the boiler to an intense heat, by burning all the coal possible with the aid of a strong draught, and generally it does not take long to produce its effects. There are other kinds of hard firing, viz., more fire on one part of the grate than another. I will cite a case of firing that came to my knowledge: The works at times would have a quantity of rosin barrels, the staves of which would be burned under the steam boiler to get rid of them; hundreds had been got rid of in this manner with no harm to the boiler, but in burning this particular lot, a sheet over the fire was cracked, and a fine boiler was placed for the time being, as they say, *hors du combat.* Now, why was injury done at this particular time? Coal was the fuel used when there were no staves to burn, and previous to this time the coal ashes were not hauled off the grate until there were just staves enough left to start a fresh coal fire with; but this time the ashes were hauled out first, and the staves burned on a bare grate; consequently, the intense heat made by the rosin staves acted on the boiler in places; the grate, not being wholly covered, allowed air to enter between the grate bars, striking parts of the boiler with a lower temperature, producing different grades of expansion in the same plate. The result was, *fortunately*, only a crack, where we might easily suppose something worse might have happened. I cannot help but think that the continued expansion and contraction going on in steam boilers, finally weaken them to such an extent that they give way sometimes and cause disastrous results.

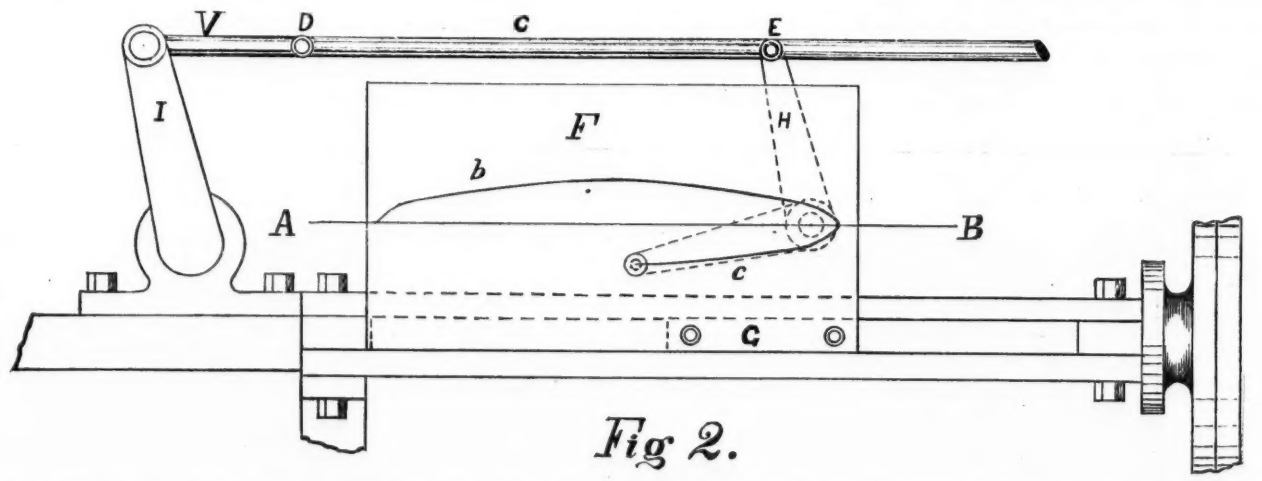


Fig 2.

It will be admitted by all practical persons versed in the use of steam boilers that they will get old; to set a limit to the number of years any certain form should be used, and then be discarded from use, would be an exceedingly difficult task to perform. Of, say, ten boilers of the same pattern, made of the same quality of iron, and set to work on the same day, no two of them would, perhaps, be in like condition in any given time, on account of the different conditions under which they were used. Kind and quality of fuel, character of the feed waters used, and the general care which each one received, would, in a great measure, determine the length of life of each boiler. But in daily practical use of the steam boiler how often is the age, or condition thought of? How many boilers are there to-day at work carrying as much pressure, fixed just as hard as they were twenty years ago, worked by the rule only that because they did sustain the pressure when new they must do it always, and they do it until the iron expands, or endeavors to, for the last time, when death and consternation is the result. The wisest heads get together to try to find the cause, everything is thought of, but the one fact, viz.: that for years the boiler had been subjected, as it were, to the torments of expansion and contraction until it could bear them no longer.

Boilers are patched up and pronounced as good as new. If the same party who superintended the patching should have his coat, or pantaloons patched, would he say it or they are as good as new? I think not. These very parties who make such expressions about patched boilers do not act, or speak of any article that have been in use for long periods of time, necessitating repairs at various times, as being as good as new. In building machinery allowance is made for expansion and contraction, particularly if that machine is to be subjected to heat, as a steam engine, for instance. If the civil engineer builds an iron bridge he thinks of expansion and contraction, making all provisions therefor, knowing full well if he does not his structure will surely be a failure. Even to the laying of the railway track provision is made—in fact, everybody that is anybody thinks of *age, expansion and contraction*, except the boiler engineer, and he pegs away until some fine day he is startled by a very "mysterious" boiler explosion.

What is the Power of My Engine?

BY E. H. ROBBINS.

A very frequent question asked of editors of mechanical papers is something like this: I have an engine with a single slide valve with cylinder 9 inches diameter, 18 inches stroke, and running at 73 revolutions. It is near the boiler, and fed by a two inch pipe. It requires 90 lbs. boiler pressure to keep it up to proper speed. There is no serious leak around the piston or through the valve. Now how many horse power am I getting from the engine?

Now the questioner, no doubt, thinks there is data enough given to receive a definite answer of just so many horse power. Sometimes the answer is, if your engine is properly built it may give you —— H. P. Some times the rule is given for them to work out for themselves. When it is, I think, this is the best way of putting it:

"Multiply the area of the cylinder in inches by the speed of the piston in feet, by the pressure on the piston in pounds, and divide by 33,000; the quotient is the indicated horse power. The effective horse power is found by subtracting the power required to drive the engine."

Now, the questioner applies it in this way: The area $636 \times 219 \times 90 = 1{,}253{,}556 \div 33.000 = 38$ nearly, and asks, does my engine give me 38 horse power?

The answer to a similar question in the * * * * a short time ago was: "Yes, if the pressure on the piston is 90 lbs."—which was correct; but they did not add that the average pressure on the piston was not over half that in the boiler with the ordinary engine.

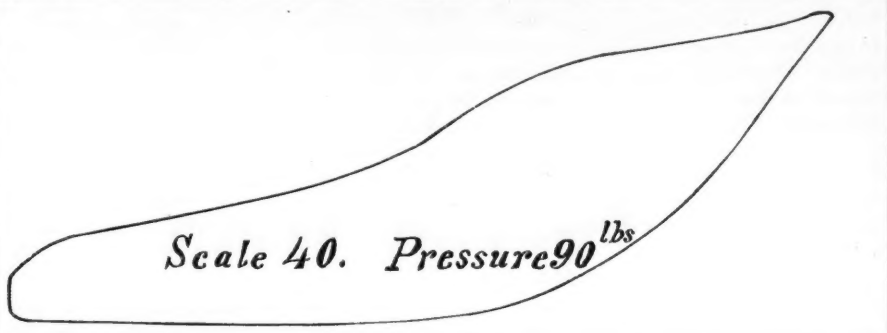


FIG. 3.

Now, a manufacturer had an engine of the size named above, and running at that speed and pressure. If the pressure fell to 80 lbs. it was much below proper speed, and as they wished to enlarge their works they decided to put in a new engine. They decided as to the kind of engine, and then came the question as to size.

The agent might have easily sold them a 10-inch engine, but he was one of those notional chaps who wanted everything fitted to its place, and wanted to sell the proper sized engine even if he did not make so much money. He persuaded the owner to have some one attach an indicator to the old engine and find just what power was required.

When the man arrived, the whole appearance of engine and boiler room, and the smooth running, trim appearance of the engine showed that the engineer understood his business and was attending to it, but he did not think much of the indicator.

His argument was: "This engine was bought for 20 H. P. We know what the size and speed is and what the boiler pressure

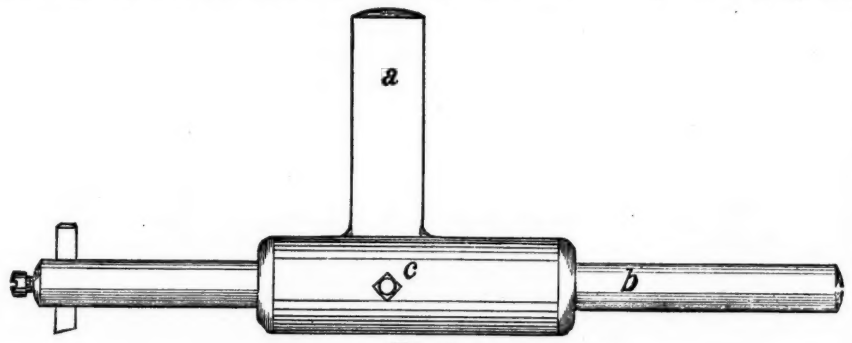


FIG. 4.

is, and it is very easy to figure that it is giving, at least, 25 H. P. It is not enough now and there is talk of enlarging the works. What we need is a 35 H. P. engine, and I don't see the need of being put to all this trouble."

"They are talking of putting in a smaller engine to get more power, which don't seem to me to be the right way to do it." He, however, good naturedly assisted in making attachments for the indicator, and presently he saw the diagram shown above.

It shows the engine was giving only about 13 H. P., and is a good illustration of the uncertainty of estimating the power without an indicator.

They finally purchased an 8x14 automatic cut-off engine, which was much too large for close economy for their present wants, but will be all right when they enlarge.

It is evident the maker of the engine tried to accomplish too much with a single valve. He was evidently convinced of the advantage of compressing to the initial pressure and of cutting off early in the stroke. I think it is probable that the valve had lap enough to cut off at one-third stroke. Now, to accomplish this with a single valve required a large engine to do a very little work, and the increased friction and condensation of the large cylinder more than used up all the gain by the great compression and cutting off at less than three-quarter stroke.

It is stated that a leading Philadelphia iron firm are importing British workmen, and are giving English machinists employment to the exclusion of American artisans.

A Swedish explorer has discovered the North-east pass they have been looking for so long. And the first thing he knows some newspaper man will be trying to borrow it from him to travel on.

Advantages of High-Speed Engines.

No. 6.

BY CHAS. T. PORTER.

In our last article we reached the formula by which to compute the force required to overcome the inertia of the reciprocating parts of an engine on the dead centers. But some readers may hesitate to admit its correctness. It is based on the identity of this inertia with centrifugal force, and it may fairly be demanded that, before proceeding further, this identity be proved.

There is nothing more simple than what is called centrifugal force, but, at the same time, there is nothing about which the prevailing ideas are more vague, and, so far as they have any definiteness at all, are more erroneous.

Probably Haswell and Trautwine may be taken to express the popular conception. The former says, vaguely enough: "Centrifugal force is a tendency in a revolving body to fly off in a straight line." Trautwine, expressing distinctly what Haswell probably meant, says: "It is that force with which a revolving body tends to fly off in a radius, or direct line drawn through said center and the body."

Now, let us see what it is. A body in motion, if left to itself, moves in a direct line. If held to a center, and compelled to move in a circle around it, it is continually being deflected from a direct line. The deflecting force is always exerted in the direction, at right angles with that in which the body is moving, and is, therefore, precisely the same

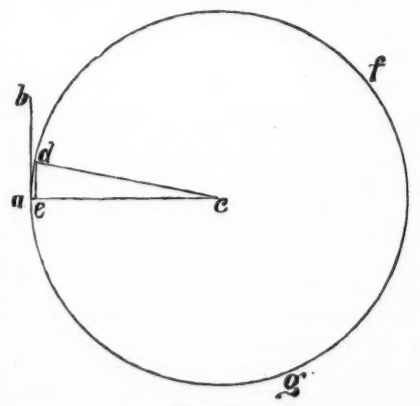


FIG. 5.

that would be required to move it at the same initial speed from a state of rest. Its resistance to this deflection is what we have been taught to call centrifugal force. If, at any point in the circle, the centripetal force, or deflecting force, or what Rankine calls the deviating force (by which he means, not a force that deviates, but one that causes something else to deviate) ceases, what happens? Why, the body simply moves on in a tangent to the circle, in the direction and with the velocity it, at that instant, had. Any one can prove this. Tie a weight to a string, and revolve it in a vertical plane. You feel the tension of the string increasing as the square of the speed, and you may fancy that the weight wants to fly off from the center, and that, if you let go, it *will* fly off in the direction of the strain. Now, at the moment, say, when the weight, moving upward, reaches the horizontal line, let go; up it will fly straight to the ceiling, at right angles with the direction of strain.

Observe the drops of water fly from a revolving grindstone; every one leaves the face of the stone in a tangent. The deflecting force was the adhesion of the water to the stone, which was easily broken. In the grindstone itself it is the cohesion of the particles of the stone. The resistance which each atom of the stone offers to the deflecting force increases as the square of the speed, and, when it exceeds the cohesion of the stone, this flies in pieces, each piece moving on in the direction in which its center of gravity was, at that instant, moving.

We see, then, that centrifugal force is merely the inertia of matter, and that the proper definition of it is: The resistance which a revolving body, or the particles of a revolving body, oppose to being deflected from a direct line of motion!

It is, in truth, absurd to call it a force, and much of the confusion arises from this misleading term. To be sure, the body, when released from the center, moves on with a force due to its momentum, but it was its resistance or inertia that released it, and nowhere is resistance properly called a force. We would not, for example, describe as a force the resistance which a railway train offers to being put in motion.

We see, also, that a revolving body does not tend to fly from the center, but, when released, moves in a line at right angles with such direction.

It is to be hoped that the compilers of our hand books, on which 99 persons, at least, out of every 100, depend for their information, will give to their readers, by and by, a definite and true statement of this action. Nystrom, indeed, does state that a revolving body released will leave the circle in a tangent, but he does not explain at all the nature of the force.

Let, now, the crank of an engine revolve in the circle $a\,f\,g$, in the figure, and let $a\,c$ be the line of centers. At a the crank is moving in the direction $a\,b$; when it arrives at d, it has been deflected through $a\,e$, the versed sine of the angle $e\,c\,d$. We should conceive of this angle as infinitely small, so that the crank is drawn absolutely to the center, and the resistance is absolutely uniform. This, however, transcends our powers. We can only form the notion of a series of steps, but these are sufficient to explain the action.

We now attach the piston, cross-head and connecting-rod to the crank, and on the dead center they, too, must move towards the center, c, through a distance equal to the versed sine of the angle, which the crank forms with the line of centers. There is one law for both. The inertia of the piston on the dead centers is, therefore, identical with centrifugal force.

Editor American Machinist:

The accompanying illustration represents a device for splining or cutting slots for keys and feathers. It has been used for some time in the shops of the American Watch Tool Co., at Waltham, Mass., and after a thorough test is found to be an economical device. The stem of the cast iron holder a, should be as large as the tool post will admit. The stem a is placed one side of the center of the holder c, in order to give a better support to the tool bar b, which is made of steel and closely fits the holder c. The tool bar b can be held in any position by the set screw located near c.

This device may be new to some, and is therefore published for the benefit of the craft.

Respectfully,

AMBROSE WEBSTER.

Measurement of Water for Power.

As water is the cheapest and best motive power for machinery where it can be obtained steadily and conveniently, a knowledge of the best methods of determining the amount of available power of a stream is of particular tmportance to the practical man. For the engraving and the information herewith given, we are indebted to Poole & Hunt, Baltimore, Md., manufacturers of the Leffel Double Turbine water wheels, who publish a very interesting and instructive hand-book for the benefit of water power users.

When it is decided to improve a water power, the first thing is to ascertain the amount of fall. The next and most important thing is to determine accurately the quantity of water that flows in the stream, as upon this will depend the amount of power, and consequently the amount of work the stream is capable of performing. And as the improvement of water power is necessarily attended with expense, it is important to one who contemplates building a mill or factory that he should know exactly what amount of work he can depend upon the stream performing; and for want of an accurate knowledge, or from erroneous supposition of the quantity of water in the stream, which is too often obtained by a mere superficial examination of the stream, parties frequently construct mills and factories of a magnitude which, upon trial, they find the power of the stream wholly inadequate to carry. This being the case, it is important to get some one well versed in hydraulics to measure the capacity of the stream. As this cannot always be done, we will here give a few plain rules, by the aid of which any one can determine approximately the quantity of water in the stream.

The engraving represents a weir or dam across a small stream. Where it is convenient to use a single board, as is shown in the cut, select one that is long enough to reach across the stream, resting in the banks at each end; cut a notch in the board sufficient in depth to pass all the water to be measured, and not more than two-thirds the width of the stream in length. The bottom of notch *b* in the board *A* should be beveled on the down stream side; the ends of the notch should be also beveled on the same side, and within one-eighth of an inch on the upper side of the board, leaving the edge almost sharp. *C* is a stake driven in the bottom of the stream several feet above the board or dam, and should be driven down to a level of notch b, this level being easily found as the water is beginning to spill over the board. After the water has come to a stand and reached its greatest depth, a careful measurement can be made of the depth of the water over the top of stake *C*, as illustrated in the cut by the man with square and measure in his hand, the dotted line *e* representing the surface of water above the stake. Such measurement gives the true depth of water passing over the notch, since, if measured directly on the notch or the board, the curvature of the water in passing would reduce the depth, giving the improper measure; although where accuracy is not required, such a method will give a fair estimate of the quantity of water. In all cases it is best to make the measurement over the stake. The line *d* is a level from the bottom of notch *b* to the top of stake *C*; the distance between surface of water and top of stake gives the true depth or spill over the weir. The surface of water below the board should not be nearer the notch *b* than ten inches, that the flow of water over the notch may not be impeded; neither should the nature of the channel above the board be such as to force or hurry water to the board, but it should be of ample width and depth to allow the water to approach the notch and board steadily and quietly. If the water passes the channel rapidly, it will be forced over the notch, and a larger quantity will pass than if allowed to spill from a large body moving slowly.

A very important matter in connection with the measurement of small streams, is also the possibility of damming or holding the water, and using it a part of the time instead of constantly. If a given quantity of water be held for 12 hours, for the remaining twelve hours (if all was used in that time), double the quantity would be available, and consequently double the power obtained for that length of time. The power is thus stored up to be used in less time, besides giving a better effect, since with small quantity of water almost as much power is required to drive the necessary machinery without labor, as when driving it at labor.

As in many cases it is impossible to construct even a temporary waist board or weir; the quantity of water that the stream can supply must be obtained by first ascertaining the mean velocity in feet per minute, and also the area of cross section of the stream in square feet; when the product of these two quantities will give the required quantity of water afforded by the stream. The velocity of such streams can be estimated by throwing floating bodies on the surface of near the same specific gravity as the water, and rating the time accurately required in passing a given distance; it must be borne in mind however that the velocity is greatest in the center of the stream, and near the surface; and that it is less near the bottom and side. It is generally best to ascertain the velocity at the center, and from this estimate the mean velocity which has been found by accurate and reliable experiments to be 83 per cent. or about four-fifths of the velocity of the surface. The cross section may be estimated by measuring the depth of stream

Measuring the Power of a Stream.

at a number of points, at equal distances apart (these points being in a line across the stream), adding the depths together, and multiplying their sum by the distance apart in feet of any two points. This will give the result required in square feet of cross section, when the product of mean velocity in feet per minute and cross section in square feet, obtains the quantity of water that the stream affords in cubic feet per minute,

Extracts from Chordal's Letters.

Mr. Editor:

* * * * I write you again from the Cincinnati Exposition. Things have got into good working order now, and that part of the show which interests your readers is entirely complete.

My prophecies regarding our exhaust pipes are being verified. In three hours the base of the flues were full of water, in three days moisture stained the walls inside and outside and threatened to sap the foundations, and now the authorities are putting in an exhaust pipe for the benefit of all the steam users. There has been a sad waste of cement in the chimneys, and the pipes will all come out and be teed into the general pipe.

Power Hall is two hundred and fifty feet long, and has two line shafts, one running two hundred, the other three hundred per minute. One would naturally look for a strictly modern job of line shaft work in such a case, and the absence of any of the usual self-adjusting hangers or sleeve-couplings is noticeable. The ceiling is supported by substantial iron columns, and on these columns seat faces are cast, against which bracket hangers are bolted. I say bracket hangers, but in fact they are simply brackets having common boxes bolted to their tops. Such a job, well put up, is O. K., of course, and hardly needs any self-adjusting features in the boxes. But, it happens that the aforesaid columns are twenty feet apart and intermediate bracket boxes are bolted to timbers framed into the ceiling work, and dropping down just far enough to receive the brackets. Aside from all errors in first alignment this intermediate system introduces a feature of elasticity into the thing, and I think most critical mechanics would say that the modern shafting devices would have been very useful and appropriate in this case. The work seems to be most excellently done and I am simply questioning the *plan*.

* * * * As an exhibitor I am of course more interested in the arrangement of the hall than in the display; and while I am at it I might as well ask why proper provision was not made for the water for the steam pumps?

What is a machine show without the steam pumps, and what are steam pump exhibitions without water? Most exhibitions are well fixed in this regard, and provide ample tanks or reservoirs around which the whole pumping fraternity can congregate. In the present case the sole provision made was a floor tank about six by fifteen feet. This was not placed so as to expose all its margins to separate exhibitor's spaces, but was placed near a side wall where only two exhibitors could possibly get at it. Others could of course run pipes to and from it, but when a man shows a steam pump he don't want a competitor to be claiming his streams. Here the most of the pump men have put in private tanks and so avoid the necessity of mingling their waters, which is certainly a good result springing from a bad arrangement.

* * * * Ohio river water is not very nice in color anyhow, and when half a dozen steam pumps churn at it awhile it don't get any nicer. It ain't nice water to look at. George has a pump or two in my neighborhood and keeps his tank supplied with laundry blueing. This ain't a bad idea.

* * * * There are two machines exhibited here for flanging boiler heads. One is a small illustrative machine, the invention of Basset, which clamps the sheet between flanges while sundry rollers turn up and form its flange. Nugent has a machine here in operation. The immense affair weighs about fifteen tons and is well calculated to terrify a boiler maker, but at the same time he must be charmed with the work it does. The sheet is laid on a former of exactly the size wanted. A revolving follower, carrying several heavy rollers having vertical axes, is fed downward with the rolls so operating on the projecting edge of the sheet as to turn it squarely down and snugly against the edge of the former. The machine, while it is immense in its proportions, is the simplest machine thus far gotten out for the purpose, as it has but two motions: rotation and a downward feed. The follower carrying the rollers is simply a big independent chuck which allows the rolls to be set for any sized head. The gradual development of flanging machines does not seem to add to the conveniences of the boiler maker, nor does it seem that the intention lies in that direction. The rolling mill becomes the owner of such machines, and the boiler maker will finally come to look upon a flanged boiler head as material to be purchased complete. I question whether some day somebody won't put up immense drawing presses, and make a special business of supplying boiler makers with every sort of flanged work, done nicely and far cheaper than the boiler maker can do it in the common way.

* * * * There are not many engines here, but what there are seem to have some points of novelty. A Brown engine drives the main shafting, and is well-known by all. The Blymer Mfg. Co., of Cincinnati, show a couple of engines with neat box beds and trunk guides, that is, the guide casting is bored out and receives a turned cross-head. The guide casting is very open and accessible. This form of guide, while long used in Europe, is not seen much here.

Traction engines from several Ohio towns are shown by their makers. Two of them have Ritchie's compensating gearing for allowing one wheel to do all the business when the engine is making short turns. Little can be said about traction engines blocked up in a room for exhibition. These engines are all threshing engines designed to transport themselves and thresher from farm to farm. No soft tires are used, the broad iron tire on the contrary being shod with heavy steel cleats. I find that these Western States are full of traction engines, and as hundreds of them can be seen in the field during harvest, I will wait a year before describing any of them, instead of detailing the merits of those which are kicking up their nicely painted heels in Power Hall.

Those familiar with the product of the Lane & Bodley Co., of Cincinnati, will be thunderstruck when they examine closely the elegant little portable engine which they exhibit. It is the nicest portable on exhibition, and from the bottom of the tire to the top of the smoke stack is full of new detail. The details themselves are hardly new, but when we see them thus brought together we must call them new. The engine frame is of the Corliss girder pattern, and has the outer bearing in the same casting, but so close to the main bearing as to provoke a doubt as to durability. The guides are bored and the cross-head is as long as the stroke, and has no provision for taking up wear.

I have had considerable experience with agricultural engines, and I give it as my opinion that this is the most efficient arrangement for securing long life, which can be put into a cross-head.

If the makers will make this cross-head fit properly the engine user will keep it so, for the simple reason that he can't help it. What is said of the means for adjusting the cross-head may also be said of the steam dome. It is excellent for there is none. It is about time American portable engine builders follow their English superiors in this respect, and leave off their useless and expensive domes. This firm have done it, but will find it up hill work in selling. The cylinder has a large jacket in very free communication with the boiler as in many English engines, and if necessary for commercial purposes this jacket may be called a dome. The pump in this engine is of the common cross-head, driven plunger form, and is run through ears cast on the cylinder. Its alignment may always be guaranteed and it is easily removable. The brass casting which contains the two valves is very neat and come-atable. That superfluity, the air chamber, has been left off. The governor is of the very commonest kind, but the design of its base, when compared with the usual cranky affairs, is simply beautiful. The axle sockets, the pintal, the bracing, and the brake work are all neat, and strong and new.

Two of the traction engines and a June portable engine shown here are of the new species, in which the boiler is vertical, and the reach from the front axle formed by the engine-bed itself. Some of these engines have new points which I wish to learn more of before I try to describe them. The Otto silent gas engine is here, doing a quiet business without any attention. You light the gas when you want the engine to start, and you turn it off when you want to stop it.

What it costs in the way of extra gas bills, is saved in the way of skilled attention, and will undoubtedly find a large market here some day, as it has already done in Europe. The Rider Air Engine is exhibited by the engineering firm of Tilden, Gray & Co. This is a remarkably simple machine, involving the most complex physical laws. In this engine the same air is used continuously, there being neither supply or exhaust pipes. There are two cylinders, one a power cylinder, the other a compression cylinder. The first is kept hot by a small fire under it, the other cool by a circulating water jacket. The air is compressed and cooled by one piston, then passed in a sheet to the other where it is expanded by heat and gives out the power. It then returns again in a thin sheet to the compression cylinder, and so on forever. The air in its passage from one cylinder to the other, goes through a regenerator which is simply a mass of iron plates having a great deal of surface. Hot air, going by these plates, leaves its heat upon them, and cold air returning picks the heat up again. The relative motions of the pistons are such, that the volume of the air, while in the regenerator, is about the same whether it is hot or cold.

In the space of Tilden, Gray & Co., is exhibited a semi-portable engine marked S. Cummings & Son, "Paradox." The circular relating to the engine says: "No stuffers to pack, no governor belt to break, no eccentric to slip, no cross-head to adjust, no slinging of oil, no moving parts exposed, no danger getting caught, no adjustment required, no skilled engineer required." To which should have been added: "No one to love, none to caress," as well as "No danger getting caught." This engine is attracting very much attention from engine builders, and seems to point toward a plan by which a good construction can be kept good. This engine is a simple reciprocating engine, having two pistons, driving a single crank. The valve is a revolving disk driven by the main shaft. The whole thing is enclosed, the projecting shaft being the only exposed moving part. There is not about the whole engine a single point where the god of ignorance with a bad monkey wrench can do any harm. The lubrication is effected by the use of a bearing composition which is lubricated by steam. There is not an oil hole to be attended to, or neglected, about the thing. The cut-off is constant, but can be arranged in the construction at any point without any derangement of the exhaust. The governor is simply a centrifugal weight graduating the area of the steam-way through the disk valve. It is not seen and can't be hurt. The governor weight is really a valve, and is not balanced. As a consequence, it can only readjust itself when the cylinder pressure about equals the steam chest pressure. This gives it two intervals during each revolution in which to find its place. At other times it is rigid. This prevents the "hunting" motion so common to centrifugal governors, and in practice the regulation of this engine has proved itself to be perfect. A small engine is found to put to the test and prove the faults of the best governors, and this little device is remarkable, *per se*, and by comparison. The boiler of this engine has developed some remarkable steaming capacity, and, taken altogether, the engine is full of promise. It is so novel that if I can get a cut of it, I will send you a complete dissection of the engine and boiler.

The Niles Tool Works show one of the "Niles" semi-portable of six horse power. This engine is a very solid and substantial machine and is much admired by critical mechanics. Its bed is of the Tangye form, stolen from the English. The cylinder has a hot air jacket, and the neat, plain exterior is charming when compared with the grease-catching complexity of most such engines. The boiler is vertical with vertical tubes. The upper tube sheet is dropped below the water line so that all fire surface has water on the other side. If I mistake not, this engine, and maybe the boiler, has been fully illustrated and described in your columns.

* * * * In machine tools, the display is limited to a single concern, the Niles Tool Works, of Hamilton, Ohio. They show their Universal Radial Drill, a tool to be seen in most every well-fixed shop, and an upright drill having some very nice points. The table is raised by means of a worm working directly into the teeth of a rack on the column. This is far ahead of the old ratchet and hook that I was brought up on, and it is better than the worm wheel motion, which requires a man to go behind the machine to raise or lower the table. The balancing weight is inside of the column, and balances either the spindle or the lower head, or both. A gauge attached to the feed work enables one to drill to an exact depth. The belt-shifter is arranged, without any trappyness, to suit any driving belt which may be used to run the machine. One often finds when he sets up a new drill, that the maker has put on a comprehensive belt-shifter, which will suit belts coming in every direction but the one he is compelled to use. A pair of boiler rolls, shown by this concern, is gotten up in sensible style. The feeding is effected by two pinching rolls, and the bending by an independent roll. My own experience with three rolls arranged in a pyramid leads me to appreciate this arrangement. I never could succeed in getting an obstinate sheet through rolls which were not arranged to pinch. A twenty-six inch lathe in this space is a good-looking tool, and is arranged so the apron can be opened like a door. This allows the interior of the apron to be inspected and oiled without tearing the lathe all to pieces. A twenty-four inch planer is here doing very heavy work with very little fuss. Little planers are my special abomination, but this one seems to take hold well, and hangs on like the toothache. The parts are very heavy, and the table motion is given by worm and worm wheel. On questioning this device, I was told the Niles Tool Works use no other planer motion, and drive the heaviest planers with a perfectly steady and noiseless power. The motion is certainly remarkably steady, and the height, belt, speed give the operator perfect control of the table.

* * * * There are many fancy engine lubricators here, some cut down through the center to show how complicated they are inside. There is but one self-operating oil pump here. That one is on one of the Blymer engines. No one seems to know just where it comes from. Some man brought it around and asked permission to put it on. I have already made one bet that the man or the oil pump came from Buffalo. * * * *

Very Respectfully,

CHORDAL.

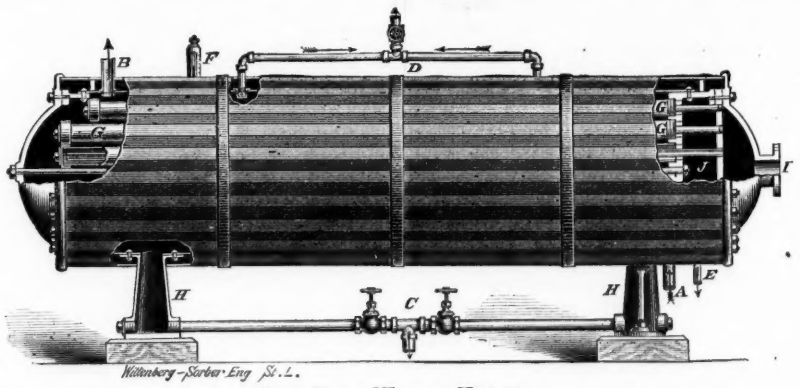
Double Action Ratchet Screw Driver.

The tool illustrated herewith is a new one of more than ordinary merit, just placed upon the market by the manufacturers, Gay & Parsons, Augusta, Me. It is a ratchet screw driver, by means of which the pressure can be maintained against the screw firmly while turning the handle backward as well as forward. By retaining the pressure continuously, the hand can be carried much steadier, and the blade is less liable to slip out of the slot and mar the work. Thus screws can be driven in much less time and with less trouble. A decided increase of strength is obtained by having the strain come upon the teeth of a steel ratchet, which is inserted into the largest part of the handle and strongly supported. The diameter of the ratchet is larger than the diameter of the wood of the ferule, which is the weakest part in a common screw driver. Steel is therefore used in place of wood for increased strength. Simply sliding the button from one side of the plate to the other throws one pawl out, and lets another into the teeth of the ratchet, changing it from a right to a left-hand action instantly, or by leaving the button midway, the blade remains stationary like a common driver. It is well made, finely finished (with ebonized handles), and is one of the neatest and most serviceable new tools that has come to attention for a long time. Single tools can readily be sent by mail.

New Ratchet Screw Driver.

The Morse Feed Water Heater.

The improved feed water heater, exhibited by a cut on this page, differs from most apparatus for this purpose in being placed horizontal, instead of upon the end, thereby furnishing a larger space at the bottom for receiving the sediment, and an equally large space at the top, to receive light impurities and scummy matter, which are skimmed off by opening a valve at the top, as here exhibited.



New Feed Water Heater.

The sediment settles in the hollow supporting legs, H, which also act as mud legs, and is blown off through blow-off pipes and cocks, C, which are so arranged that the heater can be blown off from either or both ends, as desired. The inventor claims the following, among other advantages: That it purifies the feed water in a perfect manner, removing the scale-forming matter from the same, and supplies water at a higher temperature without back pressure on the engine; that it has larger and better provisions for removing both the heavy and floating impurities than any other heater in the market. The heating tubes are made from best iron lap-welded tubes, and the shell is made of boiler iron, so as to withstand boiler pressure; the heads are secured to the shell by stud bolts, which allow their removal with as much ease as the head of a steam cylinder, thus furnishing superior advantage of access. The water being pumped cold into the heater, there is no trouble experienced with the pumps, which is a great defect in some heaters, where the temperature of the feed water is limited to a certain temperature for this reason.

This heater and purifier is manufactured by E. L. Morse, 313 Olive St., St. Louis, Mo. We understand it is in operation, giving very satisfactory results.

Engine Proportion and Construction.—Stud Bolts and the Practice of Tapping Cast Iron.

Editor American Machinist:

We all are aware that in assembling and erecting the parts of a steam engine, we are compelled to use some *stud bolts*, and must necessarily screw them into cast iron, and we are just as well informed of the fact that more than half of the stud bolts generally used for the purpose under notice, could be dispensed with, at a decided advantage as far as labor and strength are concerned.

Nearly every builder uses stud bolts all the way around on cylinder heads, and yet most of them could use the T head bolt, except perhaps in one or two narrow spots. The holes for these bolts can be drilled close to the body or wall of cylinder so that the pressure will be brought near to the *joint*, and the cylinder heads need *not* be increased in diameter. With the T head bolt, if one is broken how easy it is to replace it if duplicates are kept on hand. But some one will say: Stud bolts are all right if you only look out for them when screwing up. Yes, Mr. Editor, they are all right, *until* some man comes along with plenty of main strength and *too much wrench*, and quietly twists them off, and that is about the time they are *all wrong*.

Then there are the main crank shaft bearings, seven out of every ten of which you will find fitted with stud bolts, a locality where it is much more convenient and vastly cheaper to use the T head bolt let in flush at the sides of the boxes. And again, the bolting on of the various stands and brackets is common in design. In this matter, there is not an engine built to-day but might be so designed as to use plain square headed bolts, the heads in many cases let in their depth in casting to prevent turning when screwing up. But how many engines do we find fitted as here suggested? Few I assure you.

If it is the *correct* and *proper* thing to screw 3 inch cap bolts into *cast iron* frames and blocks, and 1 inch and 1½ inch stud bolts into castings in various places, what is the use of having *head* bolts with nuts? Why not, I say, if the practice is correct, make *cast iron* nuts for our large bolts instead of going to the expense of forging them with such care as we generally exercise? No, we know that no *sane* man would think for a moment of making a cast iron nut for a 3 in. bolt, and yet he will screw that same 3 in. bolt into a *casting* where it was easy for him to use a T or square head, and this is not an overdrawn picture at all.

But it is to be hoped that this universal practice of *tapping cast iron* will be discontinued in the near future. Let the builders start with the determination that they *will* discard *stud bolts* in every case *possible*, and the result much needed will be reached.

And now, Mr. Editor, as you have kindly allowed me much more than my share as a "grumbler" on Engine Proportion and Construction, I will beg the pardon of all your readers, especially those whom I may have unintentionally displeased by any criticism of their particular style of construction, as what I have said in these comments has been of the kindest intention on my part, and if this apology does not cover the damage, then let them rake me "fore and aft" through your plucky journal.

At some future time I will talk with you a little in the MACHINIST about *Boiler* Proportion and Construction.

WM. H. HOFFMAN,

Passaic, N. J.

The wages of puddlers at the Old Colony Iron Works, at Taunton, Mass., have been raised fifty cents on a ton.

Marine Governors.

By Chas. E. Emery, Ph. D.,
Member American Society Civil Engineers, Consulting Eng'r U. S. C. S. & R. M., formerly U. S. Naval Engineers.

In order to discuss this subject intelligently requires, at the outset, an investigation of the manner in which a governor should act in order to regulate the speed of a marine engine to the best advantage; we may then compare the different types of governor on the basis ascertained, and a place may be readily assigned to any particular apparatus under consideration.

In smooth weather, the resistance to the propelling device is substantially uniform, and no governor is needed, but, when the vessel is running directly or obliquely across waves of considerable height, the propeller is uncovered, to a greater or less extent, by the motion of the vessel or water, or both; and the resistance offered by the fluid fulcrum, being constantly modified, causes the sudden changes in the speed of the engine, known as racing, with the attendant jars to vessel and machinery. The difficulty may be often met in Government and other steamers, where time is no object, by running the engines very slowly, so that the speed, when quickened, will not be sufficient to cause injury. By this method of working most vessels could dispense with the use of a governor, and on any vessel the kind of governor employed would be of little consequence. With merchant steamers, however, it is desirable, and in making port, or an offing, sometimes necessary to urge the engine to the highest speed consistent with safety. As it is only under such circumstances that a governor is truly tested, the discussion will be based on such conditions. The problem resolves itself, then, into obtaining as much speed as possible under adverse circumstances. Whatever that speed be, it will be nearly uniform from one movement to another; the mass of matter in the vessel tending to steady the motion from sea to sea; therefore the propeller, which imparts the motion, should be revolved uniformly, or substantially so. This consideration alone shows the defects of any system whereby steam is shut off suddenly, either by hand or governing devices, when racing commences or the position of vessel changes so as to make racing probable. A spasmodic regulation of this kind cannot keep the speed of the propeller uniform, and the immersed portion of blades must actually drag, at times, and resist the progress of the vessel. It follows, then, that the pressure on the engine piston must be modified, at all times, gradually, to suit the resistance, so that the rotary and progressive motions will be substantially uniform, and the immersed portion of blades never drag, but propel at all times.

It only remains to ascertain what means shall be employed in the construction of the governor to cause the pressure on engine piston to be varied with the change of resistance, and thus produce a uniform speed of propulsion. Evidently, we may employ the well-known way, and utilize the first changes of speed caused by the changes of resistance to regulate the throttle valve to suit the resistance. It has, however, been the endeavor of many inventors to (as it has been expressed) *anticipate* the change of speed, by operating the throttle valve by mechanism governed by the pitching of the vessel, or by the height of the water in relation to the propeller. It is evident that no device can anticipate the change in resistance and yet regulate in proportion to such change. The governor must either shut off steam for a comparatively small movement of the vessel, when the propeller will drag in many cases; or the closing of throttle must be proportioned to the change in the resistance, in which case the change will be felt by the propeller as quickly as by any other device. It follows, therefore, that the governor can, at the best, only act *coincidently* with the changes of resistance, and not anticipate them.

It is by no means easy to arrange a mechanism operated by the degree of submersion of the propeller so that it will be influenced by all the changes of condition, and thereby regulate the throttle valve to perfectly prevent changes of speed. In the first place, the degree of submersion is not a perfect index of the degree of resistance. It is considered as established that, in wave motion, each particle of water moves in a circle with a diameter equal to the wave motion; so the intensity of the reaction must be varied by the various changes in the velocity of the particles of water as they regularly advance and recede, as well as rise and fall. Again, in some cases, the crest of a wave may completely envelop the propeller, and yet the mass of water directly behind the latter not be sufficient to give the maximum resistance. Any governor, then, which depends simply upon the degree that the vessel pitches, or even upon the degree of submersion of propeller, is not influenced by all the conditions. What is wanted is the actual pressure of water against the propeller blades. It is not certain that any device for measuring the pressure, located, where it must needs be, forward of the propeller, will accurately indicate the pressure behind the blades. Again, to secure uniformity of speed would require that some steam be admitted, even if the propeller were entirely uncovered, leaving only frictional resistances to be overcome, so the degree of throttle opening should not be accurately proportioned to the height of the water. This would be true for another reason also, viz.: That the more the steam was throttled the more difference in pressure there would be on the two sides of the throttle valve, and the more rapidly would a given quantity of steam flow through a given opening. It is thought, therefore, that it would be very difficult to make this form of governor regulate the speed with great exactitude; but, inasmuch as it is influenced by the principal one of the changes of condition—viz., the pressure of water at the stern—it should operate to prevent any severe racing. The pneumatic governor on this principle is now pretty well known, and is said to give good satisfaction. In this arrangement, the water under the ship's stern compresses air in a chamber, of which the changes in pressure are transmitted through a pipe to another chamber, containing a diaphragm, which operates the throttle valve. This plan graduates the movement of valve to the fluid pressure at the stern. It is, therefore, far superior to hand regulation, or any device which simply shuts off steam when the fluid falls below a certain point, or the plane of the vessel's dock is changed in relation to the horizontal, as in the latter cases, to prevent racing, the throttle must be closed when the propeller is only partially uncovered, and, therefore, capable of doing some work, and a loss of speed result, first, by not permitting the engine to do all it can with safety, and, second, by the drag of the propeller when the speed of same falls below that of the vessel. A governor operated by the pitching of the vessel, either directly by a heavy pendulum, as has been proposed, or indirectly, by more intricate devices, has still another defect, for a vessel may lie horizontally, across the crest of a long wave, with the propeller, but partially submerged, *when the throttle valve would be open and the engine race*, while, next moment, as the bow dipped, the governor would shut off steam and *slow the propeller just as the latter became submerged, and thereby retard the vessel's progress.* The pendulum plan would have the advantage of one for instantly shutting the valve when a certain angle of pitch was obtained, as it would graduate the speed, in some measure, to the degree of pitching, while the arrangement for suddenly shutting valve could not be regulated to entirely prevent racing, without reducing the mean speed of the vessel to such an extent that it would be questionable if it were not as well to obtain the same speed by permitting the engine to run throttled down, without using the governor.

Recurring to the original proposition that the speed of engine should be practically uniform, which requires that the supply of steam be regulated to correspond to the resistance offered to the propeller, it may again be observed that such resistance *can be measured by no instrument as accurately as by the propeller itself.* Ordinarily, the pressure on the piston is equilibrated by the sum of the resistances forming the load, and the speed becomes uniform; then the slightest change of load, by the operation of well-known laws, instantly produces a change of speed which will cause a good centrifugal governor to regulate the throttle valve, so as to prevent extreme changes and bring the engine back to the normal speed. A governor operating by change of speed attains the desired end with almost absolute perfection, as advantage is taken of every condition causing variation, which, it appears, is practically impossible with other systems. It is true that changes of speed are employed to produce a substantially uniform speed, but there is no inconsistency in this, as interested inventors would make it appear. It is the way of the world. All direct purposes and undertakings are accomplished by making adjustments to suit certain indications. The steersman shifts his rudder when the vessel begins to fall off her course, and the best wake is not absolutely straight. A good steersman keeps a practically straight wake by quickly making adequate correction when the vessel changes her course, and a good governor, in like manner, quickly corrects a change in speed. It is surprising how slight a change will practically answer to accomplish the purpose. Successful regulation of engines used for manufacturing purposes has been obtained where, for instance, an increase in speed at the rate of a single revolution per minute of engine would throw the shuttles out of the loom, or do some other damage. Engines developing 20 horse power may be suddenly loaded to 200 horse power, with no change of speed which can be detected by the eye by watching revolving parts. Marine governors can be made upon the same principles, and need only close attention to the details adapting them for the new service to operate exactly as well.

A brief attention to the points necessary to cause a governor to operate in the way mentioned will be interesting in this connection. The simpler form of the conical pendulum governor, in which centrifugal force simply lifts the expanding balls, is not generally used at present, as such a governor requires to be large and heavy to obtain the proper surplus of power. Modern governors are generally run at high speeds, whereby considerable power is obtained with light moving parts. The centrifugal force varies as the square of the angular velocity, so if the governor be so arranged that the separation of the balls is employed to lift a dead weight, or overcome the corresponding resistance of a spring, a higher speed than that for an ordinary conical pendulum will be required, and the apparatus have power to move the governor valve with a slight change of speed. If it were necessary in a given case that the maximum variation of speed be less than 5 per cent., and the valve required a force of one pound to move it, the safest plan to secure perfect regulation would be to load the governor, so that at normal speed it would support a weight of 30 pounds, in which case an increase of speed of 5 per cent. would increase the lifting power 10¼ per cent. and leave upward of 3 pounds surplus to move the valve, which evidently would be sufficient to shut it instantly, probably before the engine had completed a single revolution. Ordinarily, however, the change in speed would be gradual, and as soon as it became sufficient to cause the difference in centrifugal force of one pound, the valve would begin to close or open gradually, and the speed be regulated much within the extreme limits of 5 per cent. The extreme variation would only take place when the load was changed suddenly, and then would be corrected at once. A screw or turbine wheel operating upon a fluid, with the reaction lifting a weight or compressing a spring, is another form of governor which will accomplish the same results, and may more readily be made isochronous, or have exactly the same rate of speed for all practicable loads and position of throttle valve. The conical pendulum changes the rate of speed for different positions of the balls, and some complications are required to entirely prevent it, but the variation is too small in most of the modern high speed varieties to be of practical importance in most locations. A good high speed governor is so sensitive that on a single engine it will open the valve a little every time the engine passes a center, and close it again during the stroke, thus forming a kind of cut-off.

For marine governors it is necessary that the resistance in all cases be furnished by springs, as the vertical action of weights is disturbed by the motions of a vessel. To obviate this, it has been proposed to hang an ordinary centrifugal governor in gimbals like a compass, but this is unnecessary as a spring resistance is entirely practical and much simpler.

There is another form of revolving governor in which a shaft, revolved by the engine, supports a heavy fly-wheel, free to turn thereon. The fly-wheel carries fans to create resistance from the air, and receives motion from its shaft through a spring. Inclined planes or equivalents are provided to transmit the turning or angular movement of the wheel in relation to the shaft to the governor valve. In the normal condition the spring is compressed to correspond to the resistance of the vanes, and the throttle valve is open. When the engine races, the spring is suddenly wound up to a greater extent, and the angular movement of shaft in wheel shuts the throttle valve, but as soon as the speed falls below that of the fly-wheel the valve is opened. This is a heavy apparatus, but with sufficient surplus power will prevent racing.

In another governor a small engine is kept running at a constant speed, and a pulley on the shaft of same is operated by main engine. The small engine acts like the fly-wheel, in the previous example and the governor valve is operated in a similar manner, when any difference occurs between speeds of main engine pulley and that of small engine. This seems like a simple efficient arrangement but, in practice, it has been found especially liable to corrosion, so that the small engine works unsteadily when started after a long period of disuse.

Any revolving governor necessitates the use of an operating belt or equivalent, which is inconvenient, and is avoided in governors operated by the pitching of the vessel or the pressure of the water astern; but a belt is so well known by all mechanics that it should not be omitted for a less familiar arrangement, if the latter be at all liable to derangement.

An incredible amount of thought and labor has been expended on the subject of marine governors, even by persons not at all familiar with the details of steam machinery. It would seem to be not uncommon for persons to occupy themselves during a sea voyage in designing something to prevent the racing, which has perhaps so affected their rest and comfort, and often each will endeavor to bring in some features with which he is especially familiar. For instance—it has been proposed to use the regular movement of a clock to produce regularity in the movements of the engine, and one person, without apparently being aware that Watt's governor was but a form of the pendulum, which could be readily modified to adapt it for marine purposes, actually pressed into notice, with great zeal, an enlarged marine clock movement adapted as a governor in the following manner: A strong escapement wheel was given a tendency to revolve rapidly by a friction arrangement, operated by the engine. The speed of escapement wheel was regulated by the usual pallets, lever, balance-wheel and retracting spring, of proper size. By a kind of differential arrangement the motion of escapement wheel was transferred to, and *opened* the throttle valve partially at every beat, while a connection with engine *closed* the valve somewhat at every stroke. At normal speed the opposing motions neutralized each other; at higher speeds, the movement from engine predominated and closed the valve, while at slower speeds the escapement movement was the more rapid and opened the valve. During the trial of the apparatus on a land engine the noise from the escapement gear could be heard a long distance, and

the parts of same suffered rapid destruction. It bas also been proposed to use the motion of the ship or of the waves in relation thereto to close an electric circuit by which, through an electro-magnet, a small valve would be operated, and admit steam to a piston which would move the throttle valve.

This form of governor would necessarily act to quickly close or open the throttle valve, instead of graduating the movement to the change of resistance, as in the air and pendulum governors above described, which derive their action from similar initial changes of condition.

In conclusion, it appears from our investigations that the best governors for marine engines are those operated by changes of speed, as such are accurately influenced by all the changes of condition. Of these, the conical pendulum form, and that in which a fluid is displaced by a screw or turbine, will, when resistance for same is furnished by springs of sufficient strength to necessitate a high speed, give the most satisfactory results. A marine governor in which the opening of valve is graduated by the pressure of water at the stern may be considered next best, and if well designed will give good practical results. Governors acting by the pitching of the vessel are undesirable, not being influenced by all the conditions. Of this class of governor the pendulum form, which graduates the movement of valve according to the degree of pitching movement, is the better.

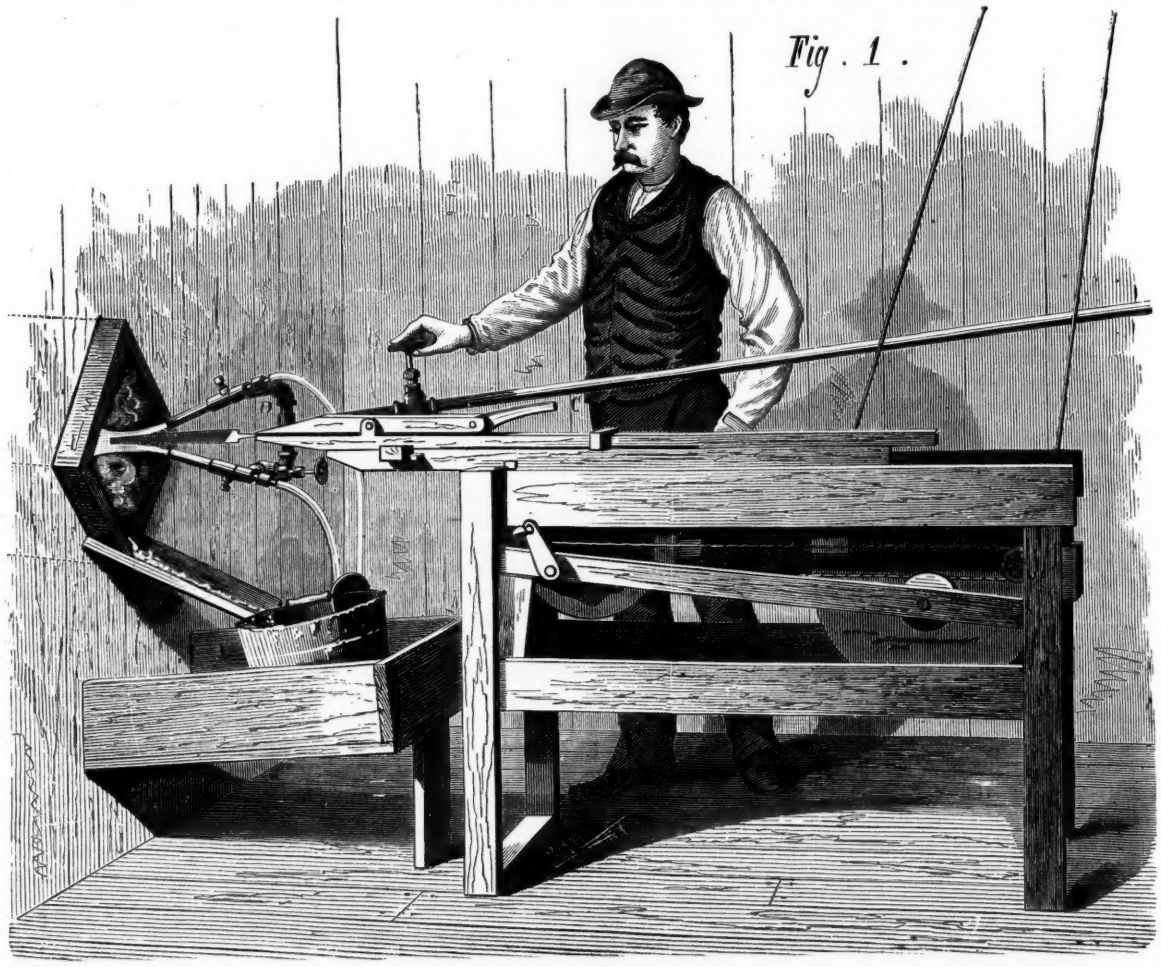
In general, any governor which opens and closes throttle valve to the full extreme permitted, without graduating the movement to the resistance is undesirable.

In determining the merits of a governor of either class, practical considerations should have great weight, and as a marine governor is, in many places, not used for months, and by chance even years, and is all the time liable to corrosion from the effects of the sea air, any arrangement which will best keep in order under such conditions is, other things being equal, the best for practical use. A governor, then, in which the principal parts are inclosed in a case and run in oil has certainly many advantages.

The space occupied, simplicity of construction and accessibility of parts are all points to be given due consideration. Any delicate apparatus requiring technical attention is undesirable, as there is always a great deal to be attended to when the use of a marine governor is necessary, and no devices should be employed which would not be thoroughly understood by members of the engineer force competent to manage the machinery during the disability of the officer in charge.

It may properly be mentioned, in this connection, that no governor can regulate speed correctly when the steam chest is very large, or, in general, when there is a very considerable space between the throttle and main valves, as the steam contained in such space will keep the engine in motion after throttle valve is shut, and must be supplied again when throttle valve is opened, thereby preventing the increased pressure from promptly reaching the piston. On land engines the action is best prevented by causing the governor to regulate the cut-off direct; but it is unnecessary to use such a complex apparatus on shipboard as a less accurate regulation will answer. The intermediate receivers of compound engines have also been mentioned as causing difficulties in regulation; but of late it has been found that a quick acting governor, of ample power to move valve for slight changes of speed, will control either single or compound engines within limits desired, unless the spaces are unusually large.

Fig. 1.



Sharpening Files by the Sand Blast.

Sand Blast File Sharpening.

The sand blast process of cutting raised figures on glass, marble, and other hard, brittle materials has been used for several years, but its use for sharpening files is a recent application.

The large engraving on this page will give a general idea of its operation. To the steam pipe (as near the boiler as convenient) is attached a ¾-inch pipe with elbow; to this is attached a piece of pipe of suitable length, inclined about 16 degrees from a horizontal line, with valve, into which a brass steam jet is screwed. Next, the iron nozzle is wrapped with paper to fit the cylinder, the steam cylinder slipped on to steam jet to shoulder, with sand tube perpendicular, and the set screws fastened. The gun is then ready for use. The operator then suspends a hopper, or funnel, of suitable size, to contain the sharpening material, as near directly over the gun as convenient, and connects with the gun by a rubber tube. When done using he removes the tube and plugs the hopper. A box is made about four feet long, one foot wide, and eight inches deep, open at end next to the gun, also underneath the outer end, for the escape of steam and for carrying sand to the reservoir. This is inclined same as the gun, and set so that the end of the nozzle shall be flush with end of box, and opposite the middle of the aperture.

The reservoir is placed under the end of this box from which the hopper is replenished as needed.

For a sharpening material moulder's parting sand is used. Flint sand or emery will wear longer, but any gritty substance may be used. The sand and water is kept in the hopper as thick as it will flow.

The file is first dipped in hot soda water and brushed with a card; should any metal remain in the grooves it is pecked out, as the blast does not remove it. The file is held so the blast strikes it at an angle of 16 degrees It is passed under the blast from point to tang, giving it also a lateral motion so as to grind it evenly. The action of the blast is very rapid. Two or more files can be placed side by side in cutting by the blast. Both old and new files are now being sharpened by the sand blast. The effect on new files is to remove the burr or curl from the teeth, thus changing every tooth into a sharp and regular chisel-shaped form. This prevents the teeth breaking off and adds largely to the working value of the file. The burr is shown in Fig. A. In Fig. B the teeth are exhibited as left by sand blasting.

Many advantages are claimed for sharpening files by this process. The temper of the steel is not drawn; they cut faster and with less labor; leave the work very smooth; are superior for wood-work, as they cut like a plane, and do not tear the wood away; can be sharpened at small expense; secure the highest economy.

H. S. Manning & Co., 111 Liberty St., New York, have the agency for sharpening files by the sand blast.

The Reason Why.

A correspondent sends us the following communication, depicting some of the annoyances met in learning the trade of a machinist. Perhaps he could have thought of still more afflictions. Had he been a clerk, or a book-keeper all his life, he might have written lamentations enough to fill every page of the American Machinist for some time to come.

Mr. Editor:

Articles are frequently seen in our papers, advising "intelligent boys" to learn a trade, rather than give their attention to bookkeeping, selling dry-goods, etc., and showing the immense advantage it would be over entering the already crowded ranks of clerks, bookkeepers and salesmen. People read these articles, nod their heads approvingly, and wonder why the advice is not followed; but if they had "been there," perhaps they could find an easy answer.

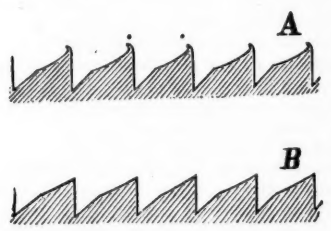
Assume that the trade to be learned is that of a machinist (the only one of which the writer has any knowledge), and consider for whom the "intelligent boy" has got to work during his apprenticeship. The chances are that the "boss" has a splendid command of machine shop French; *i. e.*, can swear like a pirate, and often like a whole crew of 'em, and if the apprentice breaks tap or drill (and where is he, who will not do this the *first* thing), he at once gets full benefit of this accomplishment. However, he soon gets used to this, and generally learns it as part of the trade.

To be sure, he has the privilege of getting up in the middle of the night to get his breakfast in time to be at work when the "whistle blows." This is good for his health, and he knows it, but sometimes can't help thinking that he would rather not be *quite* so healthy. He must not indulge this fancy tho', because if he is late he is at once refreshed with more profanity, and a yarn from the "boss" to the effect that *he never* was late, but, when a boy, used to climb over the big front gate in the morning because he was so anxious to get to his work,

> And he climbed that gate so successfullee,
> That now he is "boss" of the companee—

or words to that effect.

Once in a great while the "boss" happens



to be Superintendent of a Sunday School. Well, the best thing the boy can do is to join that particular S. S, or else "git."

After four or five years he is "out of his time"—a journeyman—that is, he goes by that name, but for some reason or other, he don't see much difference the next pay day, and finally realizes that he isn't much better than a machine, because he has been working all this time with jigs and fixtures, and really has learned no trade at all, and he concludes he has been robbed of his time, and the quicker he leaves the business, and goes to farming, the better.

Incidentally, if he happens to have an original idea in his head, he dare not advance it, because he knows that in machine shops ideas are supposed to come from gray-heads; he hasn't had the experience, therefore he *can't* know anything. If the "boss" tells him to set his tool above the center to turn a piece tapering, he must do it, no matter if it takes him an hour to file it true, in which case he is told he was an hour too long, and don't know enough to make a taper fit, when he knew all the time that if he had been allowed to set his tool on the center, where it belonged, it would fit *without* filing. These little things encourage the average "intelligent boy."

Now, suppose the young man chooses to be a bookkeeper, bank clerk, insurance clerk, or salesman. After a reasonable time he has a fair salary, two or three weeks' vacation every year, is treated like a gentleman, has less hours of labor, and is more respected by everybody. He doesn't get his fingers chewed up by gears, isn't controlled by a whistle, and, occasionally, when his grandmother dies, he doesn't have to lose the time it takes to go to the funeral.

The "intelligent boy" knows these things, and that is one reason why he don't "learn a trade."

Greaser.

"I'll subscribe for that paper," said Vanderbilt, laying down an agricultural journal he had been reading. "Its editor is a man of high attainments." His eye had caught an article headed, "Water your stock regularly."—*Exchange.*

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Special.

We wish to make the following facts fully understood by our readers:

1st. That nobody has ever paid the publishers of the American Machinist one cent for anything inserted in its reading columns, either for illustrated descriptions of machinery and tools, contributed articles, editorials, manufacturing notes, book reviews or reviews of shop supplies.

2d. That we never will publish any notice for pay, either direct or indirect, except in our advertising columns.

3d. That no party interested in making or selling machinery, engines and boilers, or in their manipulation has, or ever has had any pecuniary interest in the American Machinist.

The Commercial Traveler System.

Our country is noted for occasional popular movements in peculiar directions. At one time the matchless medical properties of blue glass are heralded widely by the press, and the people rush forthwith to glass dealers, putty merchants and glaziers, giving them such a lively patronage as they never before experienced. Windows opening upon the streets and over sky parlors are made to resemble checker-boards with their alternate squares of blue and white, while young and old become seized with a fondness for basking in variegated sunshine. Staid old citizens wonder why they never before discovered the curative virtues of sunlight strained through blue window panes, and, after a trial, add their testimony to the record of its wonderful results. Then the press drops blue glass and it ceases to be a theme of common conversation. Windows gradually assume their normal appearance, and trade declines at the glass and putty stores. Those afflicted with cricks in the back return to old-fashioned liniment and mustard plasters, and, for a time, everybody pursues the even tenor of his way. Suddenly the press raises a new mania This time it may be spelling matches. From the urchin who has just learned to form b-a-k-e-r, to the septuagenarian, the whole community becomes deeply interested in correct orthography. The district school house, the town hall, and the more pretentious "academy of music," each becomes scenes of animated spelling contests, and the victor, who "spells down" all the rival candidates for orthographical honors, is greeted as the champion and presented with a prize. Again the press leads in a new departure, and again popular enthusiasm is diverted into a new channel. From contests of mind our interest centers in contests of muscle. Public admiration flies from the development of brains to the development of legs. Mental caliber retires to make way for animal force and endurance. Patronage is transferred from the book-making savants of the intellectual arena to book-making gamblers of the sawdust arena. The pedestrian mania is at its height, but when that dies out, what next? Surely something must be found to draw popular enthusiasm. We have had the mania of curative remedies, of mental powers and of muscular powers, and it remains to have a mania on some system in the way of conducting trade. A few of our exchanges are aiding to start it up.

It is the abolition of the commercial traveler, or "drummer" system. The discovery has been made, according to some of the papers before us, that the ambition to sell large quantities of goods and get a wide run of trade has led to the system of employing travelers to solicit and receive orders, which is "an extravagant method of doing business." It has, in their view, concentrated business in the hands of a few, so it is difficult for young men of limited capital to get a fair start. How these young men could get a start at all, were the whole system of traveling to solicit trade done away with, our contemporaries do not discuss. So long as human nature remains as it is, efforts of beginners to obtain trade in competition with old established houses, by sending out circulars and letters, without visiting buyers, or sending special representatives to visit them, will always be a decidedly up-hill kind of work. Whether the trade be in dry-goods, groceries, hardware or machinery, beginners will find that without direct personal efforts their business is not likely to grow to such proportions as to become "the town talk." Individual, face-to-face solicitation is a course adopted because it is found necessary to obtain orders and extend trade. When this is well directed the auxiliary aid of the mails works to the greatest advantage.

It necessarily costs considerable to market manufactured goods as well as to produce them. Here is where ability, energy and tact assert their powers. Far the larger proportion of men who enter business do not succeed, mainly by reason of wrong conceptions in its management. There are more failures in selling than in manufacturing articles worthy to compete in the markets. The fact that nearly every large mercantile house, whose business is selling goods of any kind, has built up its business largely by the aid of commercial travelers is evidence enough of the value of that system. We notice in some of our exchanges occasional delectable reports of interviews with merchants and manufacturers who have dispensed entirely with drummers.

Smith tells how he had been foolish enough to pay out large sums every year to traveling salesmen, which he had finally discovered subtracted just so much from his profits. Then he "bounced" them all a few weeks ago, and is doing a larger business than ever, and at so much less expense that he can sell goods ten or fifteen per cent. cheaper than his rivals. The publication of such interviews works well for Smith for a very limited time, and if his customers were not interviewed by the traveling salesmen sent out by Jones and Brown, would, doubtless, continue to do so. But here is where the new plan is defective. Smith's customers being offered goods by enterprising traveling salesmen as low as he is selling, yield to their persuasions and leave him "out in the cold." It will not take him many months to discover his mistake, but it may take some years to get back the trade he lost, if, indeed, it is ever recovered.

It is asserted that, by the united action of merchants and manufacturers the commercial traveler system could be abolished, and a great saving effected. There is no probability of any such action being taken. The most efficient methods of selling, as well as of manufacturing goods, will be followed by the most enterprising and successful establishments, and no efforts of disgruntled competitors will avail to return to the obsolete systems pursued by the ancient Knickerbockers.

Iron Trade Prospects.

The remarkable advance in iron, within the last three months, has given an impetus to business such as it has not experienced before for several years. Pig iron, in the New York market, has advanced fully fifty per cent., and still further advances are certain to be made. Bar iron appreciates very regularly, and purchasers complain that they cannot get their orders filled when required. Three months ago, buyers were accustomed to debate with the seller about the price of iron. Now they are most exercised about the earliest date they can have their orders filled. The question as to how long these advances in prices will continue to be made, and what figure will be reached, is the most important one now present for discussion. That there is a limit to the prices that can be obtained is evident, also, that, at the present rapid rate of increase, it must be reached before many months more. Those best informed in the iron trade express the opinion that iron will not advance, up to the close of this year, as rapidly as it has for the corresponding time just passed. The importing price has been reached and passed. Considerable contracts have been placed in England for bar iron, rails, scrap iron and old rails, for use in this country. Scotch pig iron has obtained a new lease of way in our markets, and, of course, shares in the increased prices. Swedish iron, of which large stocks are now held by the makers, is selling briskly among our manufacturers, as the price has been very low, and has advanced but little, thus far. The future advance on this side of the water will, therefore, depend very much upon the advance in Europe. The English iron market is severely depressed, but has already begun to react in sympathy with our rise. That it will recover as speedily as the iron interests of the United States can scarcely be expected. Consumers of iron are buying (many of them) for future, as well as for present use, and, unless business is remarkably prosperous, are not likely to repeat their orders for some time to come. Those who have taken contracts, to execute in the future, requiring large amounts of iron, may find themselves doing a losing business, unless they have bargained for the iron in season. One peculiarity of the rising market is the uncertainty in making prices for future construction of boilers, machinery, and other iron work.

As no one can calculate what the price of iron, or of labor will be a month hence, the seller takes, in most cases, more risk than the buyer. Some apprehension is felt that, with all our mills and furnaces in full operation, the market will become overstocked, and prices go down as rapidly as they went up; but those best qualified by long experience to judge the situation, can see no cause for alarm. The fact must be borne in mind that prices of iron were abnormally low, and that a considerable portion of the advance was necessary to place the trade upon a fair paying basis.

With the increasing demand in this country for railroad bridges, rails, cars, and supplies from South and Central America, Mexico and Cuba, the requirements for iron are likely to be greater rather than less. Those who expect to see prices of iron lower within six months will probably be disappointed.

The new steamship City of Alexandria, built by John Roach & Son, Chester, Pa., was recently visited by a number of representatives of the press of this city while lying at Pier 3, North River. She is 333 feet long, 38 feet 6 inches wide, 25 feet deep from the spar-deck, and 33 feet deep from the hurricane deck. The machinery is constructed with several new improvements. The high-pressure cylinder of the compound engines is 42½ inches diameter, and the low-pressure cylinder, 78 inches, with a stroke of 54 inches. There are four boilers, each 10 feet long, and 14 feet 6 inches diameter, each having four furnaces. Steam is furnished at 80 pounds pressure. The total grate surface is 345 feet. The propeller is 16 feet 3 inches diameter, with a pitch of 25 feet. The wood-work is neat and substantial. The first cabin accommodates 150 passengers. She will be a fast running vessel, and a credit to American shipping.

Prices of machinery are very slow to advance, but manufacturers have been obliged to increase their figures for selling. The present cost of the metal used in a large lathe, or planer, with the extra cost of labor, enhances the whole cost of the machine five to ten per cent over the amount it required to build it three months ago. Tool builders who adhere to old prices will probably experience difficulty in "making both ends meet." With small machines and tools the incentive to an advance is the increased cost of labor and shop supplies, as well as a more lively demand.

The substitution of steel for iron in steam boilers is one of the important mechanical improvements of the times. Steel is now made possessing the peculiar qualities needed in boiler shells with far greater durability than iron, and greater strength for resistance. The expense of building steel boilers is but little more than that of first-class iron, while the additional security given is worth much larger outlays and efforts.

LITERARY NOTES.

REPORT ON A PRELIMINARY INVESTIGATION OF THE PROPERTIES OF THE COPPER-TIN ALLOYS, made under the direction of the committee on metallic alloys, United States Board to test iron, steel, and other metals, by Robert H. Thurston, Chairman in the Mechanical Laboratory of the Stevens Institute of Technology. Published by the Government Printing Office, Washington, D. C.

The investigation of the properties of alloys of copper and tin, reported upon in this work, were entered upon under a resolution of the United States Board to test iron, steel and other metals, passed April 17, 1875, directing a determination of "the mechanical properties and of the physical and chemical relations of alloys of copper, tin, and zinc," and under the arrangement of the committees approved by the Board, April 23, 1877, which assigned to the Committee on Alloys the duty of "assuming charge of a series of experiments on the characteristics of alloys, and an investigation of the laws of combination." This research was conducted in the Mechanical Laboratory of the Department of Engineering of the Stevens Institute of Technology, under the authorization of the trustees. This preliminary study of a wide and important field will doubtless prove to have been so satisfactorily done that a repetition of the work may never be required, and that in the future, research may be thus profitably confined to matters of detail in those parts of this field which are here shown to be of most promise, and where investigation may be most certain to yield liberal returns. Prof. R. H. Thurston, in addition to his own skill as an investigator, was supported in this enterprise by some of the best talent that this country can produce, and this work bears the evidence of conscientious and skillful labor in the investigations. The object of these investigations were not to ascertain the value of metals, compounded under special care and composed of the purest metals, but rather to ascertain the practical value of the metals of commerce, as usually found in the markets of the United States, and manipulated in the same manner as such alloys are prepared in every foundry for business purposes, cast, and otherwise treated as the brass-founder usually handles his work. The special endeavor has been to determine the practical value to the brass-founder and the constructor, of commercial materials, treated in the ordinary manner, without any special care or precaution in their treatment. In regard to special fluxes and various methods of treating alloys after casting, is reserved, as the object to be attained in this work, the mechanical properties of copper, tin and zinc. The extensive diagrams annexed to the work fully illustrate the variations of these properties. These diagrams form a very essential part of the work, and were taken from the original, which were made by the Autographic Recording Testing Machine, which was invented by Prof. Thurston and is pretty generally known. The work commences with a preliminary experimental research upon the mechanical properties of small castings of the alloys of copper and tin, number and character of mixtures, embracing the first and second series of tests, also divisions of bars for the several tests. These are advanced by weighing the metals with the most delicate apparatus, which was sensitive to an error of less than $\frac{1}{20000}$ of the whole. The next step is the compositions, by original mixture and analysis, with results, method of casting the bars, appearance and changes in the same and properties.

Tests by transverse stress are next considered with a full description of apparatus, and Methods of Testing (Illustrated) with description of appearance of fractures. The next is Tensile stress (Illustrated), with description of apparatus and methods of testing. Tortional stress is fully elaborated with appropriate illustrations, also directions how to determine the results in each case with copious notes. Among the more important tests are those of compression, as the data concerning this particular branch has heretofore been limited.

The second series of experiments deals with the proportions of mixtures, analyses, methods of casting, and temperatures. Then follows the tests of the different mixtures in the same order as in the first series, with appropriate tables and illustrations. A summary is then taken, and different authorities compared applying to each particular case. A valuable addition to this work is the tabulated records of individual tests. It is beautifully illustrated by photographs of fractures of copper and tin alloys. There are also numerous select papers on metallic alloys by Professor Thurston, together with earlier researches on properties of metallic alloys.

All parts of the work bear unmistakable evidence of hard work and careful investigation, and all the minute details are fully explained. This work is one of the many monuments which the author has erected, and will long outlast his life, besides being of inestimable value to the community interested in this kind of investigation.

ENGINEERING DRAWING.—Lithographs of machine construction, drawing and building construction, comprising plans, elevations, and sections of all those details of construction specified in the syllabus of the Science Directory. Subjects 2 and 3 are drawn to a large scale, showing clearly how work is put together, in order to assist students to pass the Government examinations; by W. Busbridge. This work is published in sheets 11"x17", of which there are 59 now out, and can be purchased singly or collectively at a uniform price of ten cents each. Sold by E. & F. N. Spon, 446 Broome st., New York.

The above work is indeed one which has long been needed, for previous to the publication of these sheets all the copies that the student could obtain were either embodied in some expensive book or were published with description in the French language. Each of these plates are drawn to a scale which accompanies each one, and in addition to being useful as drawing copies, they are properly proportioned so that they may be used as working drawings. The dimensions of the important parts are given in plain figures, with letters attached giving the proper name of each part. These drawings are not colored, but are represented in black lines just as an ink drawing would appear when finished. This work has only to be examined to be appreciated. Those who contemplate the study of mechanical drawing will do well to examine this work, particularly the practical mechanic and apprentice, who cannot afford to purchase the more expensive works. We would recommend the plan of commencing with No. 1, and take up each number consecutively until the whole are obtained, unless it is thought best to purchase the whole at one time.

Hutchinson's Bulletin is a spicy little sheet, issued "semi-occasionally," by E. H. Hutchinson, 440 Main St., Buffalo, N. Y. Mr. H. conducts a general newspaper advertising agency, and his *Bulletin* is a stroke of enterprise put forth to post advertisers. He has a good business acquaintance and (unlike some general advertising agents) a thorough reputation for reliability in his representations.

Business Specials.

Forty cents a line for each insertion under this head.

The Huntoon Steam Governor Co., of Lawrence, Mass., warrant a direct saving in steam of from 10 to 20 per cent. over any other Governor known; while for quick and accurate regulation, great durability and lasting economy in use, they guarantee results never before attained by any other. See advertisement.

Brown & Sharpe M'f'g Co., Providence, R. I., keep in stock at reduced prices Patent Cutters for the teeth of gears which can be sharpened by grinding without changing their form. All wheels of same pitch cut with them will run together correctly. Send for new catalogue.

Castings, Gear Wheels and other parts of models, at lower rates than can be made by hand. Tallman & McFadden, 607 Market St., Philadelphia.

Steel Stamping Letters, Figures, and Dies, 1-16 to ¼ Figures, per set, $1.00; ⅜ Figures, $3.00. American Tool Co. Cleveland, O.

National Steam Pump, simple, reliable and durable. Send for illustrated catalogue with reduced price list. W. E. Kelly, New Brunswick, N. J.

Three second-hand Boring Mills for sale cheap. One of 9 feet swing and two of 5 feet swing. These mills must be sold, and can be bought very low. Write for description. Fuller Trump, Springfield, Ohio.

Questions and Answers.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly and according to common sense methods.

(1) A. B., Lynn, Mass, writes: What is the value of coal dust compared with ordinary furnace coal dust, composed of nearly equal parts of Franklin, Lackawanna, and Pictou? Bituminous is generally used here. A. Under ordinary circumstances there is no special advantage, but with a properly-constructed furnace the dust of coal is preferable, for the reason that a loss is experienced in the reduction of coal to a dust after it is placed in the furnace, and the larger the lumps, the greater will be the loss from this cause. It has become a recognized fact among engineers that to obtain the best results in firing, small coal should be used, hence its adoption on steamboats. Before coal can be of any service in a furnace it must be converted into a gas, and as dust is nearest to a gas it has been found the most economical. The invention of G. K. Stevenson, of Valparaiso, with which extensive experiments were tried in England some years since, and other experiments lately tried in this country, have established the facts before asserted. The coal should not be powdered and allowed to lie out of doors, as it will lose some of its properties, and become comparatively valueless. It should be properly housed and taken care of. 2d. Will you please name some elementary work on the steam indicator, and where it can be obtained? A. "An Elementary Treatise on Steam and the use of the Indicator," by J. C. Graham, C.E., 8vo. cloth; price, $3.50. The book mentioned is an elementary treatise, and may be procured through any dealer in scientific books.

(2) H. M. D., Cleveland, Ohio, writes: Please inform me why it is that machinists reverse the screws when lowering the cross-head of a planer, as it is a practice in every shop where I have worked? They say it is to take up the loose play. In lowering the cross-head, if the whole weight hung on the screws, as it ought to, it would hang the same lowering or raising the head. On the other hand, if the head fitted tight, in lowering, the nuts would crowd up against the threads on the screws, so if there was any pressure under the head it would not move up any. A. We do not fully understand the latter part of your question, but in relation to the former we would say, that it depends altogether upon who built the planer, upon which the experiment is to be tried. The cross-heads upon some planers may be raised and lowered uniformly by loosening the nuts one-quarter of a turn; while on others, where the slots in which the bolts move have not been planed, are liable to catch at all points. It is best for the workman to satisfy himself that the weight rests uninterrupted on the screws, which may be done in the most simple way, by reversing the motion. 2d. I overheard a dispute between a machinist and a locomotive engineer about eccentrics. The former said that stationary engines did not have but one, but afterwards admitted that some had two. The locomotive engineer said that all stationary engines had two. I am a machinist and agree with the former. A. There are locomotives, stationary, and marine engines running to-day in this country with three eccentrics, also some that have no eccentrics (excepting the marine engine). We have inspected them.

(3) G. J., Mobile, Ala., writes: Can you tell me where I can get a book on the manufacture of gas, containing processes, etc. I am young in the gas business aged 22, and desire to get all the information possible. I desire to make it a practical study, and make myself thoroughly acquainted with every practical process. I would like to get the best works on the manufacture of artificial light, construction of apparatus, etc. A. The best work that we have ever seen on the above subject is entitled "A Practical Treatise on the Manufacture and Distribution of Coal Gas," by Wm. Richards, demy 4to; illustrated with large plates; cloth; price, $12. Another work on the same subject, cheaper than the former and less complete (although a good work) is entitled, "Analysis, Technical Valuation, Purification and use of Coal Gas," by the Rev. W. R. Bowditch, M. A.; illustrated; 8vo., cloth; price, $4.50.

(4) L. O. C., Sedalia, Mo., writes: In the AMERICAN MACHINIST of August 23d, 1879, article of L. F. Lyne, M. E., much information is given in regard to lathes and lathe spindles, etc. 1st. Will he be so kind as to give the correct way to parallel a lathe spindle? A. It is supposed that this operation applies to lathes that have been running for some time. First remove the live center and fit a plug to the hole in the spindle, letting the plug project beyond the end of the spindle about one inch; remove this plug and fit another to the same hole, letting it project about twelve inches, according to the size of the lathe. Now place the small plug in position, also a very fine steel point in the tool post, and bring it up so that by turning the spindle the point will describe a small circle on the end of the plug; run the carriage back carefully, remove the short plug and insert the long one; bring up the point and describe a circle on the end, in the manner described, and the difference in the diameter of the two circles will be the amount of variation in the spindle. The point, when first set, should coincide with the center of the circle, and the variation in the height of the centers of the two circles will determine the amount that the spindle must be raised or lowered to bring it level with the shears. We think that the reader will understand the principles from the foregoing illustrations. If an old lathe has been fitted with new boxes and it becomes necessary to bore them out, we recommend the plan of letting one end of the boring bar run on the dead center, and fix up a temporary center for the other end and feed the head along the shears by means of a screw, for by this device little skill is required to bore the boxes in line, but by any other means there are many chances for variation. 2d. What is the correct way to line a lathe with counter shaft, both ways? I have seen a 24 inch lathe, having a heavy double leather belt on it full width of cones, and they cannot run it at all on the fastest speed, as the belt climbs and twists. Please explain. A. Set the shaft level, also shears of lathe; drop a plumb line from each end of the counter shaft, then take a straight-edge and placing it against the planed side of the shears, and from it measure the distance to each of the lines, and adjust the lathe until they measure alike. The fact of a belt running badly is not conclusive evidence that the shaft is out of line, as the fault is frequently in a poor quality of belting. The width of a belt should be less than the face of the cone to allow for any variations in the belt.

MANUFACTURES.

It is thought that the Altoona, Pa., Car Works now being rebuilt, will be in operation by December 1st.

It is thought the shipments of machinery out of St. Louis for the present year will considerably exceed the sales of any year in the history of the city.

The DeLaney Forge Company, Buffalo, N. Y., are building a large addition to their shops in order to accommodate their trade, and are now increasing their force of workmen.

A company styled the "Tyler Hoe and Tool Works" has been organized at Ironton, with a capital of $30,000. Operations will be commenced in about five weeks, and the capacity of the works will be equal to the production of 500 dozen hoes per week, but at the start only 250 dozen will be made per week.

Work on the addition to Peter Simpson's mill, at Millbury, Mass., is progressing finely. It is of brick 60 by 48 feet.

The pay of the nailers at East Taunton, Mass., has been voluntarily raised ten per cent.

Pottsville puddlers and helpers are happy over an increase in their wages.

The Tremont Works, Wareham, Mass., have advanced the wages of puddlers, nailers, and flat mill rollers, ten per cent.

The moulders at Morris & Marshall's foundry, Pittsburgh, Pa., were paid an advance of wages two weeks ago, without any previous knowledge of the increase.

Morris, Tasker & Co., Philadelphia, advanced the wages of their employees, Sept. 19th, without solicitation.

The Crane Iron Co., Catasauqua, Pa., advanced (voluntarily) the wages of their workmen ten per cent. on the 19th ult.

John Wentzel, White Horse, Pa., is building a new blacksmith shop (for wagon making) 54x22 feet, which will be fitted up in the best style.

The moulders employed at the stove works of March, Brownback & Co., at Limerick, have been given an advance of ten per cent. on their wages.

A voluntary advance of ten per cent. in the wages of the moulders at the Judd Manufacturing Company, at Wallingford, Conn., have been made.

The wages of the employees at Schantz & Keely's foundry, at Spring City, Pa., have been increased five per cent., and there will be an additional increase of five per cent. on the 10th of next month.

It is safe to say that in nearly every iron mill in Reading there has been an advance in the rate of wages. The Reading Iron Company's puddlers are receiving an advance of twenty-five cents on the ton, and the helpers an advance of ten per cent. At F. J. Obert's Union Boiler Works some of the hands have received an increase. There is a disposition among operators to retain their men and keep them at work, and rather than have trouble reasonable requests for an advance in wages are granted.

Jordan, Marsh & Co., have leased their mill at Ashland to the Warren Thread Co., of Worcester, Mass. This company are putting in a Wheelock engine, and the steam power will be furnished by two 54″ x 16′ tubular boilesr, set with the Jarvis Furnace. They will burn screenings for fuel, using the Mahony Patent Grate.

Smith, Vaile & Co., Dayton, Ohio, employ 30 men, are shipping steam pumps to Mexico and Russia, are full of orders and expect to buy more machinery.

F. M. Riegel & Co., (Trade Engine Works), Dayton, Ohio, are enlarging their machine shop and appointments, and expect to have their new foundry and boiler shop complete some time in October. At present they cannot keep pace with their orders, which come mainly from the South and North West.

The Missouri Car Wheel and Foundry Company are now engaged in transferring their car shops from Indiana to St. Louis. A suitable building is now being erected.

The Western Iron Boat Building Company have three iron hulls under construction for the Government service in removing snags on the Mississippi River. These boats are constructed with a heavy iron hull and iron stern wheel. The rudders are to be worked by steam engines bolted to the deck, the wheel simply used to control the engines.—*St. Louis Journal of Commerce.*

The firm of Boynton & Plummer, Worcester, Mass., was constituted Sept. 1. It is composed of E. N. Boynton, well known as proprietor of the Worcester Hand Tool Works, and Osgood Plummer, late of the Lathe & Morse Tool Co. They have just put in some new machinery, giving an enlarged capacity to the old establishment of E. N. Boynton, and will manufacture the shaping machines, blacksmiths' upright and horizontal drills, bolt cutters and other tools, which have given this concern a reputation in almost every civilized part of the world.

York & Smith, Cleveland, Ohio, report business very active. Besides supplying the Lake Erie Iron Co. with an entire outfit for making nuts, bolts, and washers, they have sold to Gill's Car Works, Columbus, a large nut machine; to the Vulcan Iron and Nail Works, Chattanooga, an outfit for making nuts, and have sold three of their new self-feeding circular shears to cut sheet metal up to ¼ in. thick and 12″ from edge.

The Furst & Bradley M'f'g Co. are about to erect a three-story foundry and machine shop on Jefferson street, corner Fulton, Chicago.

The Niles Tool Works, of Hamilton, O., lately received an order from Gaud, Belgium, for an immense ten-foot boring and turning machine, weighing fourteen tons. Alex. Gordon, superintendent of the works, states that they have a full force running night and day, and prices of machines are looking up.

The moulders at Ainslee, Cochran & Co.'s foundry, Louisville, Ky., who struck a few days since for an advance from $2 to $2.25 per day, have had their demands acceded to, and they returned to work.

Capitalists in Vincennes, Ind., are moving to organize a stock company to erect a starch factory upon the site of the Knox Starch Works, destroyed by fire in August. The capacity, if built, will be 1,000 bushels of corn a day.

The Furniture Workers Co-operative Association, of Chicago, lately held a meeting at which it was stated that 1,600 shares had already been subscribed, and if 200 more were obtained, the Association would be able to go ahead, elect directors and get ready for spring trade. A number of shares were subscribed for at the meeting and the plan will doubtless be carried out.

Jones & Laughlins, Pittsburgh, Pa., have advanced the wages of their machinists $1 per week.

D. H. & J. C. Newton, Holyoke, Mass., are preparing to build a new mill for the manufacture of manilla paper and ground pulp from poplar and spruce wood.

The workmen at the works of Hubbard, Bakewell & Co, manufacturers of saws, shovels, axes, etc., on Dinwiddie street, Pittsburgh, Pa., on the 21st ult. went out on a strike. The firm recently changed their method from semi-monthly to monthly payments, and the workmen objected. The strikers also declared that they would not resume till an increase of ten per cent. in wages was also given them. The firm granted the demand as to semi-monthly payments, and work was resumed on Saturday. The men at the works at Beaver Falls, operated by the same firm, are also out on a strike for about the same thing.—*American Journal of Industry.*

A brass factory at Moncton, N. B., is projected.

D. J. G. Arnold, New London, Ohio, has just brought out a model four-horse steam engine for pumping and other light work, which promises to have a large sale. He has also recently purchased the patterns and drawings of the famous Lewis wood and iron lathes, and begun the manufacture of them on an extended scale.—*Cleveland Trade Review.*

Wm. T. Bate & Sons, of Conshohocken, Pa., have built a boiler weighing 14,000 pounds for a woolen and cotton mill in Bridgeport, which takes the place of four other boilers.

The Alx. Smith Co. are increasing the capacity of their carpet mills at Yonkers, N. Y., by the erection of a new building 250 by 52 ft. at their "upper mills," also a new extension 120 by 68 ft. and four stories high at their works on Palisade avenue.

The American Starch Works, at Milwaukee, are turning out from a ton and a quarter to a ton and a half of their product daily, and Kirby & Pavey, the proprietors, propose to either enlarge their present accommodations, or to build a new establishment.

The Cumberland Nail and Iron Works, of Bridgeton, N. J., has voluntarily advanced the wages of workmen ten per cent. A similar advance has been made by Morris, Tasker & Co., and the I. P. Morris Co., of Philadelphia.

F. W. & I. M. Munroe have purchased a tract of land at Marblehead, and are to immediately erect a shoe factory thereon. The main building will be 40 by 135 feet, 3 stories high, and will be built of wood. In the rear will be a brick engine house containg a 25 horse power boiler. Still further back is to be another building which will be 33 by 50 feet, 2 stories high. Preparations for building have already been commenced, and the structure will be ready for occupancy in about two months.

Fraser & Chalmers have just completed one of the most extensive boiler manufactories in Chicago, and are now laying the foundation for a machine shop and warehouse nearly as large as their former main building. They employ 150 men this season.

C. B. Tebbetts is to erect a large building at Lynn, Mass., to be occupied by him as a shoe manufactory. It will be built of brick, its dimensions being 108 by 80 feet, and six stories in height.

S. R. Heywood & Co. have just completed the purchase of a lot of land at Worcester, Mass., and propose to begin at once the erection of a boot factory, of brick, covering three sides of the lot. The front will be about 140 feet, with two wings, each 40 feet long, and an engine, and boiler house, and chimney in the center. The front will be 3½ stories high, and the wings 4 stories. The firm is compelled to make this change by the increase of their business, which has outgrown their present quarters. The new building will be completed, it is expected, about January 1st.

Barnstable, N. H., is to have a new shoe factory to replace the one destroyed five years ago.

Silk manufacturing is soon to be commenced in Philadelphia. The "Sauquoit Silk Manufacturing Company" is the name of a company that has made application to a court for a charter of incorporation.

Certain parties in Milford, Mass., propose to form a company for the manufacture of boots and shoes, the capital to be raised by subscription, and the workmen to share in the profits or losses. Those who furnish the necessary capital are privileged to select a general manager, who shall buy stock, superintend the manufacture and employ competent salesmen, or otherwise dispose of the goods manufactured. All workmen to be employed at the regular price of labor in the several departments, and to be paid nine-tenths of their earnings, every week. The remaining ten per cent. to be reserved as a guarantee fund to insure the capital against loss. Every six months an inventory is to be taken, and, if the business shall have been found unprofitable, the guarantee fund shall be devoted toward reimbursing the capital. If the business has made a profit, the entire guarantee fund will be returned to the workmen in proportion as it was deducted from their wages. The subject of a co-operative shoe factory has been discussed in this town for several years, and the projectors believe the plan will be successfully carried out. It is reported that the owner of a large factory has offered the use of his building, rent free, to make a trial of the scheme.—*Boston Com. Bulletin.*

The Orange Foundry Company of Orange, Mass., who are now melting about 10 tons of iron daily, a large part of the castings made being for the sewing machine company, have decided to build an addition to their works. The building is now 175 feet long, and when the addition has been made it will be one of the largest of the kind in the region.

It is reported that parties in Wilmington are to offer the Baldwin Locomotive Works twenty-five acres of land, eligibly located within the city limits, and provided with water and railroad communication, the said twenty-five acres to be donated to the company free of charge on condition of the removal of the works to that city.

The Buffalo Car Works, located in the city of Buffalo, and covering a space of twelve acres, have been leased by a newly-formed organization, to be called the Gilbert Car Company. The works have a capacity of from five to twelve cars a day, and contain all of the recently patented machinery necessary for their successful operation. It is probable that work will be begun under the new auspices very soon.

At the present time hardly a good machinist, carpenter or competent day laborer can be found out of employment in Westerly or Pawtucket, R. I.

The Boston & Fairhaven Foundry, at Fairhaven, Mass., has resumed operations.

Machinists' and Engineers' Supplies.

If activity in the supply stores of this city may be taken as an indication of a rushing business, it is here and likely to stay with us for quite a time yet. There is not much sending out of printed prices and discounts, for the reason that they are liable to change on some goods two or three times a week.

Boynton & Plummer, Worcester, Mass., have issued a new price list on blacksmiths' upright drills, horizontal drills, tire benders, bolt cutters, hand and power shapers, and crank planers, which they will mail upon application.

The E. Horton & Son Co., Windsor Locks, Conn., have issued the following price-list of the Sweetland Improved Horton Chuck:

THREE JAWS.

6	Inch	Diameter	$26 00
9	"	"	34 00
12	"	"	44 00
15	"	"	52 00
18	"	"	62 00
21	"	"	80 00
24	"	"	100 00
30	"	"	170 00
36	"	"	230 00
36	"	" for Car Wheels	250 00
30	"	" " "	185 00

FOUR JAWS.

6	Inch	Diameter	$32 00
9	"	"	42 00
12	"	"	56 00
15	"	"	64 00
18	"	"	75 00
21	"	"	95 00
24	"	"	120 00
30	"	"	200 00

A. Fisher, Cleveland, Ohio, has recently started a machinery agency at 66 Bank Street, having, among other specialties, the local agency for the Baxter Portable Engine.

Frasse & Co., 62 Chatham St., New York, are to receive in a day or two 1,000 scroll saws of the improved Demas & Holly pattern. They are having an extraordinary demand for their new screw cutting engine lathe.

Morgan & Herrick, 86 John Street, New York, are introducing a new Plumbago Journal Lubricator for machine shops, printing presses, cars, &c. They send sample boxes on order, subject to approval.

Iron Review.

New York, Oct. 3d, 1879.

While there has been no large advance during the past week in prices of iron and steel out of store, yet the present store prices are same as mills now ask on the cars, and consequently as much lower as the cost of freight, cartage, &c., into store. On descriptions of iron which cannot be imported, a further advance in prices is imminent. The demand is good and the market has a continued upward tendency.

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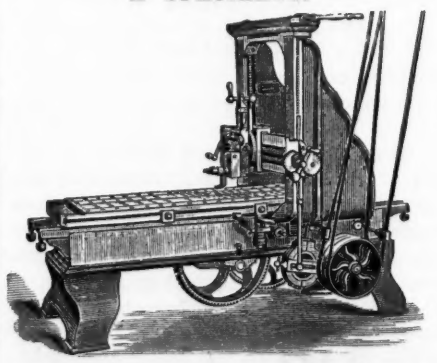
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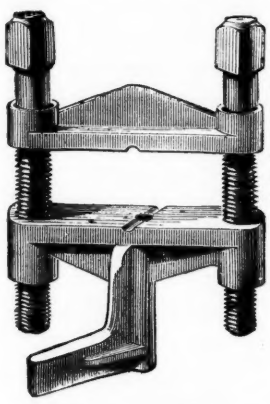

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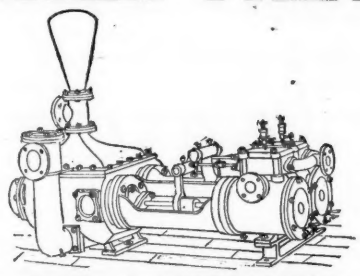

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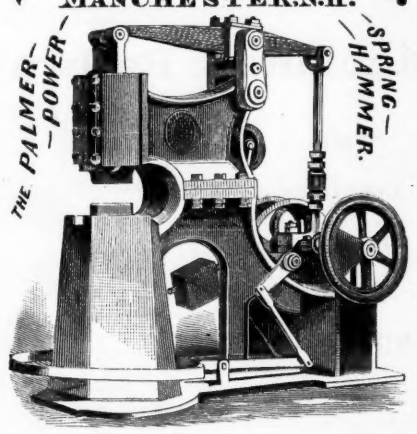

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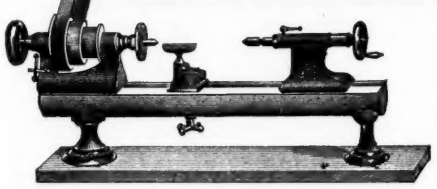

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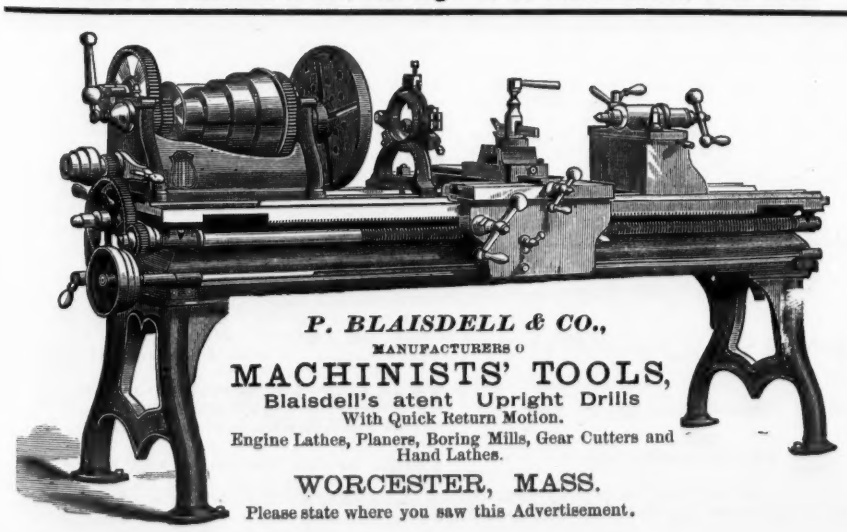

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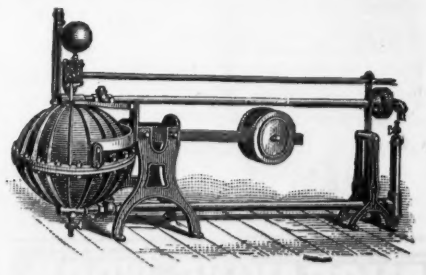

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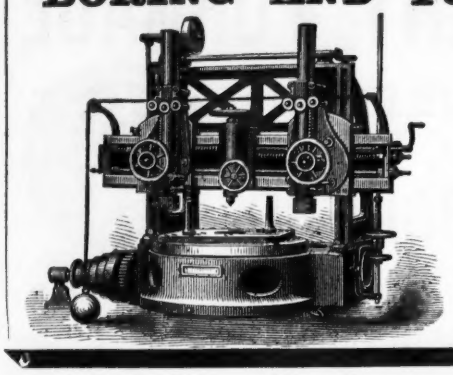

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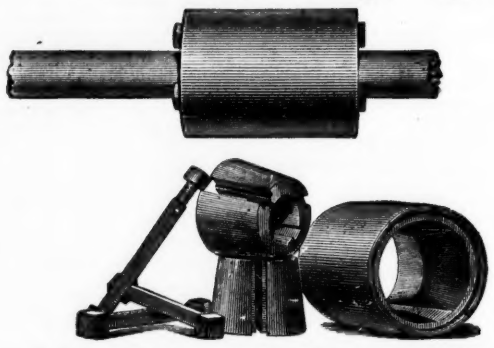

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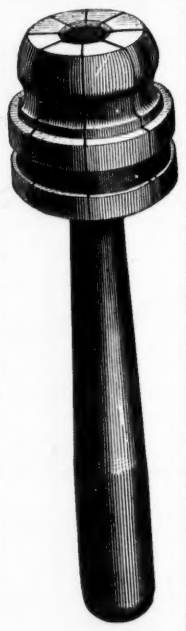

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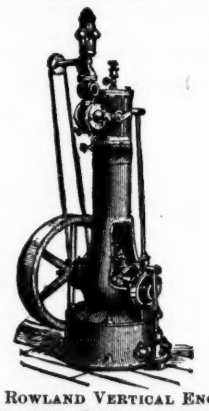

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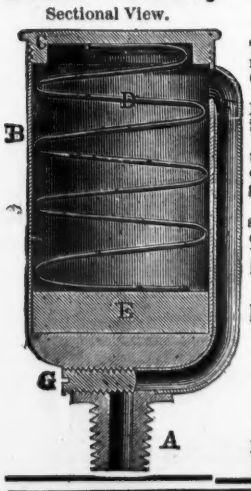

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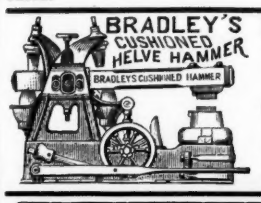

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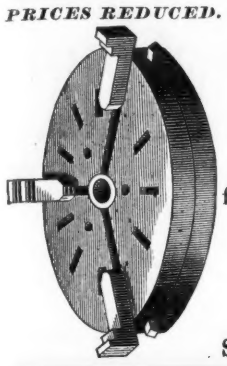

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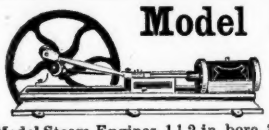

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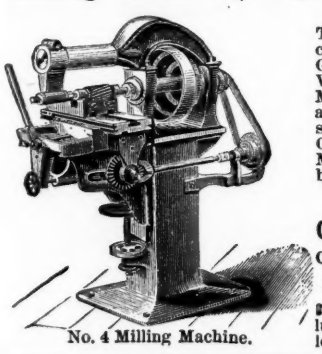

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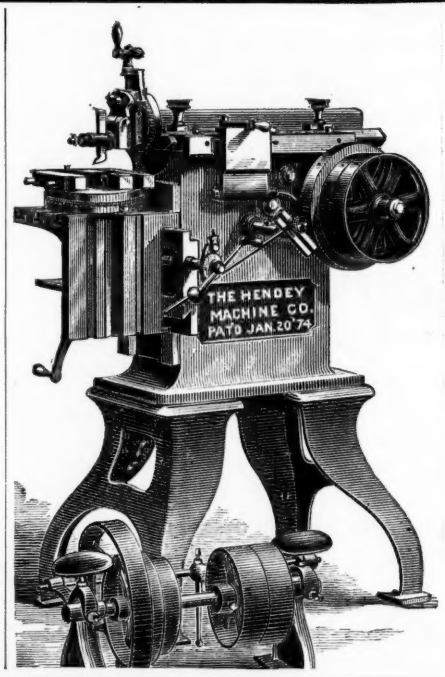

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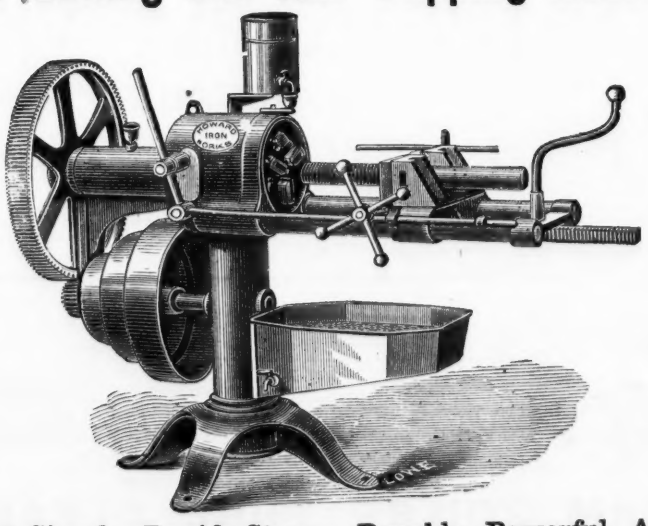

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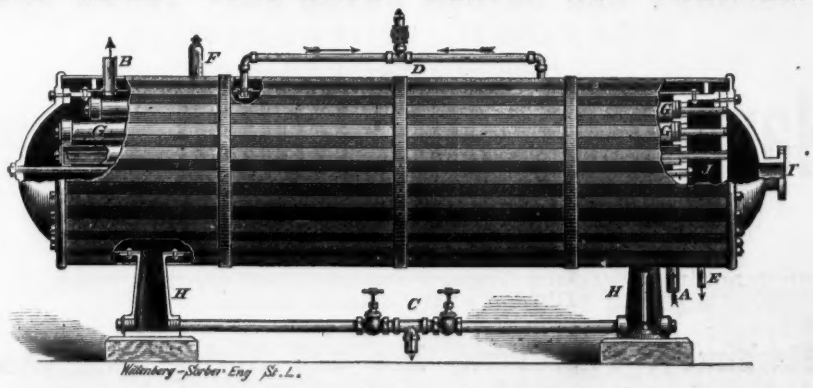

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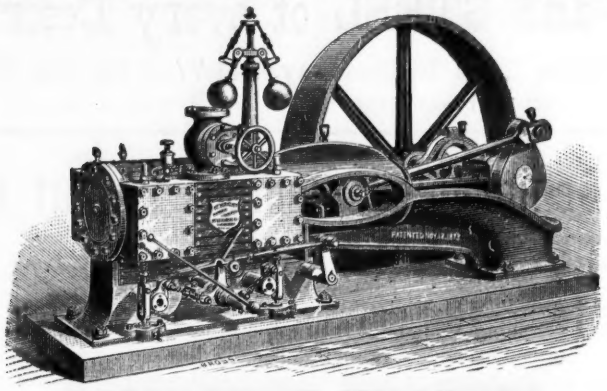

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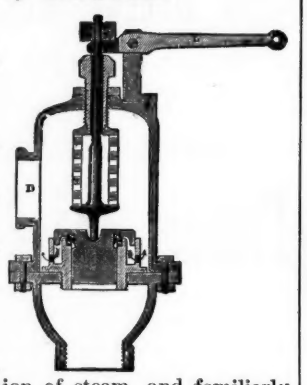

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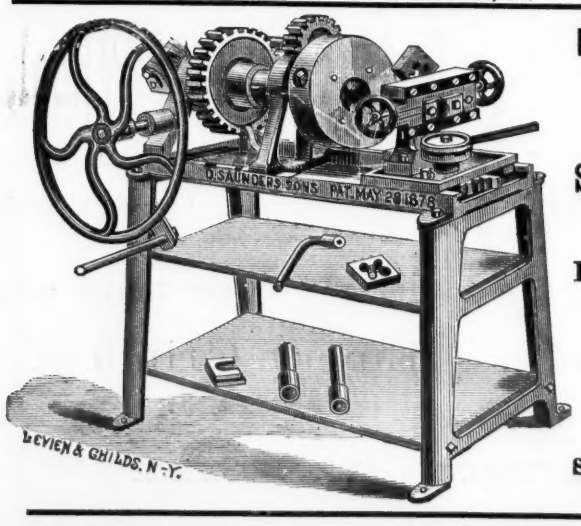

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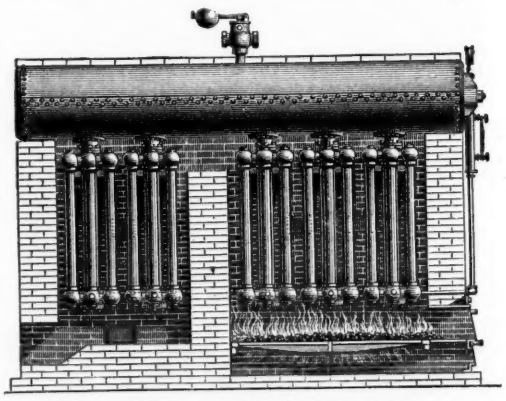

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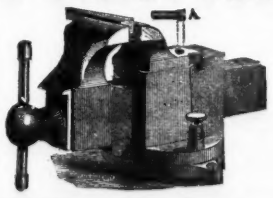

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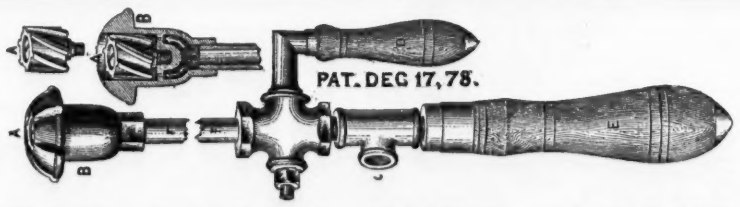

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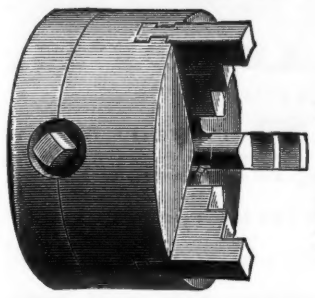

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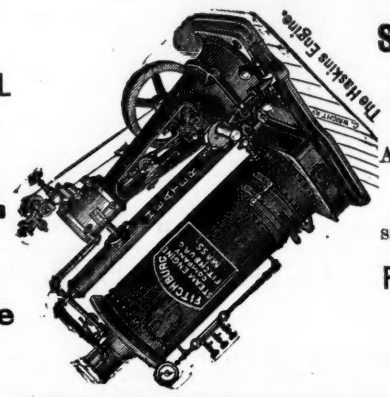

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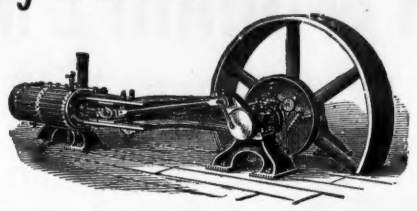

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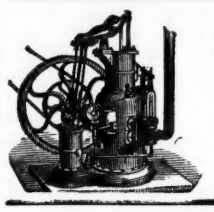

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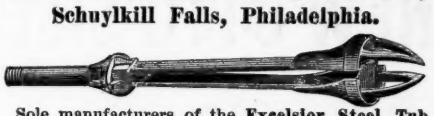

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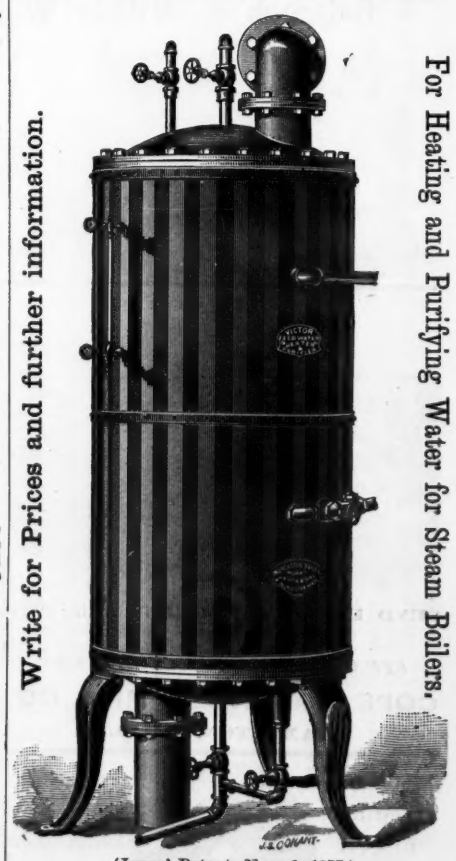

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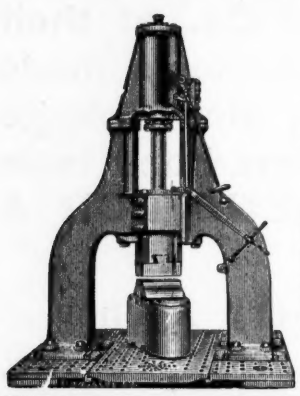

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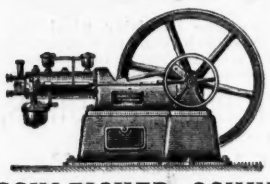

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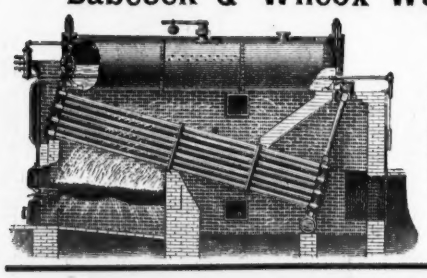

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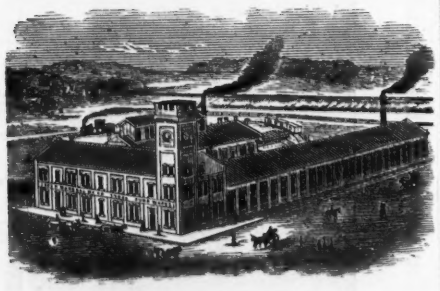

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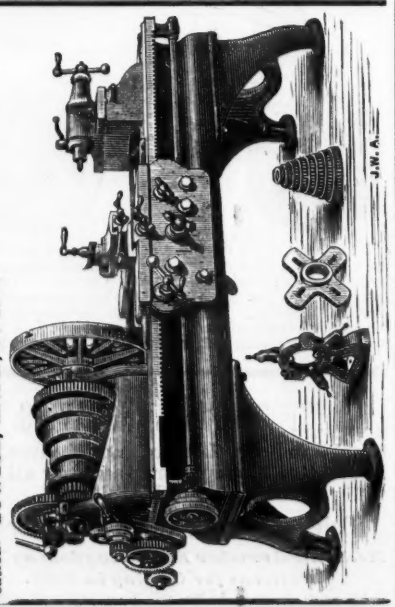

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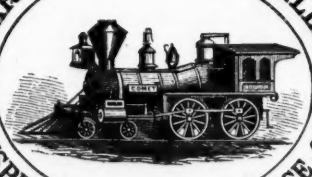

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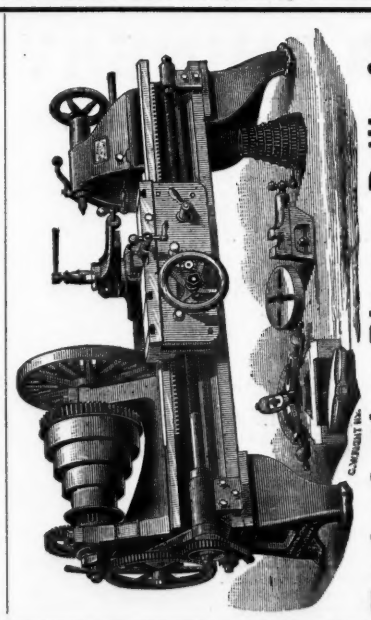

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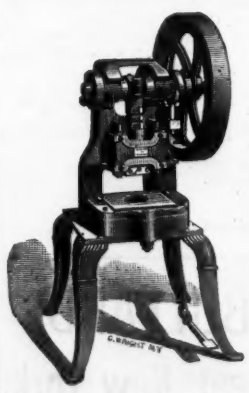

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